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Professor K. Koffka

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Author of *The Growth of the Mind*, who has accepted an invitation to Smith College from Giessen

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OCTOBER, 1927 Vol. 8, No. 2

EDITORIAL

THE ORTHOLOGICAL INSTITUTE

The moment having arrived for Orthology to take itself seriously, as insinuated in our last issue, it behoves the Orthological Institute to place on record its achievements during the past ten years, and to formulate its programme for the coming months as concretely as possible.

Hitherto, be it first explained, the Institute has worked by proxy. Its aims, that is to say, have been subserved by a variety of undertakings, diverse in form and origin, through which the new science has made its influence apparent. It is not necessary to elucidate these complexities at this stage, for the functions and duties of stepmothers have seldom been profitably defined, and it is as a stepmother that *Psyche* must be primarily regarded in this connexion.

As the organ of the Orthological Institute, however, *Psyche* will feature during the coming year six major problems of general linguistic.

1. *Forensic*: concerned with the neglect of linguistic technique by jurisconsuls.
2. *Chromatic*: concerned with the commercial and artistic possibilities of colour notation.
3. *Grammatical*: concerned with the present parlous plight of linguistic education.
4. *International*: concerned with the future of English and its rivals in international communication.
5. *Cryptic*: concerned with signific and symbolic systems which at present baffle human understanding.
6. *Bestial*: concerned with the technique of animal communication.

The first will involve primarily a fresh analysis of legal evidence, which is being undertaken by Mortimer J. Adler; and the elucidation of what may be called Polar Bearings on the lines of Boris Bogoslovsky's forthcoming *Technique of Controversy*. The second depends in part on the date of that Exhibition of the Science and

Art of Colour which remains a desideratum in Manhattan, though there is still room for wisely oriented psychological research such as that presented by Mr. Marston in our current issue. The third will receive the attention of the authors of *The Meaning of Meaning* as soon as the economic wherewithal is available. The international problem is yearly becoming more acute, but the efforts of Mrs. Dave Morris and others are gradually preparing the way for fruitful research. Fifthly there are the undeciphered symbols of primitive man no less than the equally mysterious symbols of the superphysicists. Finally there is the study of the elaborate sign systems and emotive languages of animals, which will ultimately prove the chief means of furthering the aims of humanitarian organizations.

Painless Extinction

The practical applications of these various lines of research will only be obvious as the research itself proceeds. As with Aeronautics it has proved possible to disturb the sleep of the whilom sceptic by nocturnal gyrations above the clouds, so those who now labour in the early hours to rise above the verbal fog that still envelopes human thought may, even during their own lifetime, disturb the intellectual slumbers of the unimaginative. For the most part it is we ourselves who will profit by the new methods and attitudes, but in one particular field the whole of the brute creation may also enjoy their benefits.

Only when the problem of animal communication has brought home to scientists and public alike the very dubious character of our present attitude to animal intelligence and animal sensitivity will the horrors of our slaughter houses vanish in response to humaner demands. The foundation of a Society for the Study of Animal Psychology and Animal Communication, with a full sense of its subsidiary humanitarian significance, is therefore an undertaking which *Psyche* wishes all possible success.

A MINIATURE A MONTH

Just eighteen months ago, *Psyche* announced that she had so successfully launched herself as to be able to turn her attentions elsewhither. Hence, the Psyche " Miniatures ", both Medical and General with a triple appeal—cortical, optical, and topical.

Our programme, a Miniature a month over the first two years, has not only been justified by the reception of the series, but is now approaching completion. The eight volumes already published in the General series will be followed during the next few weeks by as many more. *On History*, and *Fatalism or Freedom* will precede the contributions of Wheeler, Claremont, Needham, and Stefansson, and the ' Diffusion ' symposium is also already in the press. In the Medical series, *Migraine* (Crookshank), *Aphasia* (Wilson) and *Types of Mind and Body* (Miller) have prepared the way for our October sextet Sir Humphry Rolleston's *Idiosyncrasies*, Dr. O'Donovan's *Dermatological Neuroses*, Dr. Crookshank's *Diagnosis*, Dr. Ray's *Rheumatic Diseases*, Dr. Culpin's *Medicine and the Man* and Dr. Hurst's *The Constitutional Factor in Disease.*

With twenty-four volumes thus in being we are in a position to sponsor from time to time essays and treatises of psychological import in a larger format. The first of these (Psyche Monographs, No. 1) will be *The Origin of Instinct*, Professor Bugnion's illustrated study of the War between the Ants and the Termites, with his Lamarckian inferences therefrom. The price of this particular item will be 5/-, and since only 400 copies will be printed before the type is finally distributed, our advice to all who enjoyed Professor Bugnion's original article in *Psyche* is that they should order early.

PRIMARY COLOURS AND PRIMARY EMOTIONS

By WILLIAM M. MARSTON

Columbia University

Problem

The Hering colour theory, which has been adopted, with modifications, by perhaps a majority of psychological experimenters, supposes the existence of four primary colours: yellow, blue, red, and green.[1] It is clear, of course, that these four hues must be psychological and not physical primaries, since the wave lengths of light capable of acting as adequate stimuli to vision vary in a continuous series from about three hundred and ninety millionths of a millimeter to approximately seven hundred and sixty millionths mm. No physically nodal points have yet been discovered, in this long series of different wave lengths, which might constitute physical elements corresponding in any way with the phenomena of visual sensation. From the point of view of physics, every wavelength is elementary, and there is no reason for considering any one colour more elementary than any other.

What, then, are the reasons for selecting red, green, blue, and yellow as psychological primaries? There are between five and six hundred thousand distinguishable colour sensations.[2] each completely unitary in so far as its conscious perception goes. Moreover, if we select as colour-elements those sensations which, when blended, will produce all other visual sensations, we may choose the red, blue, and green originally postulated by the Young-Helmholtz theory, or we may pick out various other triumvirates of colour. But selection of primaries on such a basis seems to leave unaccounted for various phenomena connected with complementary colours, colour-contrasts, colour-zones of the retina, and the different types of colour-blindness.[1] It is not the purpose of the present paper to discuss at length the adequacy of the red-green-blue-yellow selection of primaries in accounting for all the exceedingly complex visual phenomena which have been reported to the literature. But it does seem of interest to the present discussion to note the principal basis for what may be termed the

Hering choice of primaries. That choice appears to rest, ultimately, upon the apparent existence of distinct retinal colour-zones: a centre-most zone, sensitive to all visual sensations, *including red-green*; an intermediate zone, sensitive to blue, yellow, and grey; and an outermost zone, yielding grey sensations only. A reasonable conclusion is thereupon drawn that our retino-cerebral apparatus must contain separable mechanisms of at least three types: a black-white mechanism, a blue-yellow mechanism, and a red-green mechanism.

But is it a reasonable conclusion to assume that the psychologically important part of each differentiating colour mechanism is its receptor organ? Grant, if you like, the existence of as many different types of retinal end-organs as there are distinguishable colours in the spectrum. Assume that each type is equipped with a different photo-chemical substance capable of responding selectively to an appropriate wave length of light. And imagine, further, that these diverse photo-chemical substances are so arranged with respect to each other that they interact in the most marvellous way to correspond with all the automatic alterations of hue found in colour contrasts, after-images, and other visual phenomena. Have we, then, explained or described the *consciousness of colour*? Certainly not. We have only described, so far, a highly complicated physiological apparatus for transforming physical light stimuli into chemical nerve stimuli. No one, I suppose, who still concedes the existence of consciousness and assumes that the description of this phenomenon is psychology's proper task, would rest content with the idea that the reaction of a photo-chemical substance in a retinal receptor *is* the consciousness of a correspondnig colour sensation.

When appropriate sensory nerve fibres have responded to a photo-chemical impulsion, and a propagated disturbance has begun travelling up the nerve toward the brain, a few bold, decisive theorists might assert that such propagated disturbance within the nerve *is* consciousness. A majority of psychologists and physiologists, however, would maintain that consciousness does not occur until the brain itself is excited. They would conceive the production of consciousness to be an undefined and unlocalized function of some unnamed portion of the cerebrum. These authorities would not be satisfied to ascribe colour-consciousness to any part of the peripheral, intra-neuronic disturbances. For my own part, I hasten to agree, so far, with current opinion. But I have tried to be more specific about the location of consciousness, and what it is.

I have, in fact, suggested[8] that consciousness, in its physical

aspect, actually consists of psychonic (inter-neuronic) energy; and that it occurs upon the psychons (junctional tissues or connective nerve filaments) at all central synapses. Colour consciousness, then, for me as for the psychological majority, would first exist (in appreciable quantity, at least) in appropriate visual and sensory centres of the central nervous system. It is hard to see how the existing hypotheses concerning photo-chemical substances in the end-organs of the retina advance materially our knowledge of what goes on in the brain centres. As a first step toward tracing the energy changes in the central psychons following the exposure of the retina to light, attempted description of the original receptor-transformers might be valuable (were it based on known bio-chemical fact, which, at present, it is not). But with a complete and accurate description of retinal receptors before us, we should still be faced with our really vital psychological problem, namely: *how are the essential light-colour differences conveyed to the central psychons, and what constitutes, on these psychons, the consciousness energy constituting colour sensations*?

Personally, I cannot escape the conclusion that psychology must look continuously to neurology for its immediate presuppositions. In the problem under discussion, for instance, grave difficulties appear the moment one attempts to formulate an account of the translation of receptor-organ differences in the rhythms or intensities of photo-chemical (?) stimulations into corresponding differences of nerve impulse rhythms or intensities. We are confronted, for example, with the all-or-none law of nerve conduction. If a given nerve fibre responds at all to end-organ stimulation, it responds in its entirety; that is, with its maximally intense train of intra-neuronic explosions, called nerve impulse.[4] Then there are the matters of refractory periods, latent period, after discharge, and temporal summation to be considered.[5] It seems rather naïve to hypothecate a visual substance in an end organ magically capable of imposing its own desired rhythm and intensity of vibration upon a contiguous conducting nerve; and still more naïve to imagine that this peculiar intensity-rhythm arrives in statu quo at the psychons where it must undergo integration with millions of other impulses. Neurologists no longer believe that differential qualities of nerve-impulses exist[6]: and quantitative differences must depend upon the number of unit nerve fibres stimulated, or, possibly, upon additional impulses superimposed upon a given fibre by stimuli of supraliminal intensity, simultaneously with the impulse native to that fibre. No other ways are known by which even intensity differences can be communicated from one end of a conducting nerve

to the other.[7] Is it not rather fatuous to sit complacently with folded hands, a full supply of Hering, Young-Helmholtz, or Ladd-Franklin photo-chemicals in our laps, fully convinced that in the unexplored virtues of these imaginary substances lies a secret code of communication between light and the brain?

At any rate, it cannot be denied that the final consciousness-energy units of colour sensation will have to be described in terms of intensity and inter- relationship of central, psychonic (or nervous) impulse relationships. Nor can it be denied that an enormous reduction, by integration, of separate visual nerve impulses of origin must also be described, similarly in terms of nervous (and psychonic) impulse intensities and interrelationships, before description of primary colour sensations, or even just-distinguishable colour-sensations can possibly be arrived at. There are probably more than one million separate, conductive nerve channels in the optic tract (as estimated by Krause).[8] Each of these channels, or nerve fibres, presumably obeys the all-or-none principle of nerve impulse conduction: that is, each fibre, when excited at all, is excited maximally. Is it quite thinkable that four—or forty—primary colours should be manufactured in finished form at the peripheral ends of these one million nerves, should lose their identity within the conducting nerve trunks due to the operation of the all-or-none law, and be revived again magically at the central synapses? It is possible, of course, that some ingenious lover of puzzles might work out a series of mechanisms able to accomplish this result; but he certainly would be compelled to resort to a new set of imaginary substances within the nervous system more numerous even than the mother and child photo-chemical family conceived for the retina by the fertile brain of Mrs. Ladd-Franklin. On the other hand, is it not extremely reasonable to suppose, basing our reasoning upon facts definitely known, that *colour sensations* (which are ultimately, it must be remembered, impulse intensities and relationships) *actually come into being at the integration of the million or more visual impulses of origin*?

Of course, the intensities of nerve impulses integrated (or the volumes of simultaneous discharge over given nerve fibre groups which represent original intensity values), must be sharply and definitely predetermined, in some way, by the wave length of light stimulating the retina at that moment. That is to say, integrations which may be supposed to manufacture sensations, must primarily be influenced in their method of manufacture by the raw products with which they have to deal. We may pertinently inquire how many different types of retinal receptor organs need to exist

in order to " get the light waves on the wires " of the optic tract. Several photo-chemical substance theories postulate three or more types of receptor organs. Structurally, we know of only two types, rods and cones. But it is quite easy to imagine as many different sorts of cones as may seem necessary to any individual theorist. With no facts concerning photo-chemical or other differences between cones to tie us down, there seems no logical reason, at least, to call a halt with the Ladd-Franklin or Helmholtz list of three or four types. Why not have one hundred fifty to two hundred thirty, one for each pure tint that can be distinguished in the spectrum ?[3] The modest limitation to a single pair of cone types found in the original Hering theory seems to be based, as we have already noted, upon the existence of " red-green " and " blue-yellow " zones in the normal retina. The first suggestion to present itself to one's mind, perhaps, would be the postulation of a certain green-red type of cone in the centre-most zone of full colour vision, and the exclusive presence of another type of cone, the blue-yellow receptor, in the blue-yellow zone.

Two outstanding facts present themselves, in consideration of this two-cone-types hypothesis, however. First, there is no evidence whatever of any difference, structural or chemical, between different cones. Second, and perhaps more important, there is very positive evidence that all the retinal cones are connected by identical synaptic arrangements with similar conductive fibre groups in the optic tract. Whatever differences may exist, therefore, in the impulsions delivered by retinal end-organs to these conductive fibres must thereupon be translated into differences in the number of fibres energized. It is conceivable that one type of cone might always be capable of stimulating ten fibres, and that another type of cone might always be able to stimulate double that number. But, in that case, there would be likely to appear a difference in thresholds, between the two types of cone, in sensitivity to light. Such a difference of threshold, in fact, appears clearly as between cones and rods, both lower and upper limens being, apparently, lower in rods than in cones. It seems to me, on the whole, far simpler to suppose that the rods are a cruder type of receptor, incapable of generating enough energy to stimulate a very large number of nerve fibres ; and to regard the cones as more potent end-organs, capable of stimulating a greater maximal number of fibres when fully aroused, and also capable of stimulating lesser numbers of fibres when themselves less intensely stimulated.

If such were taken to be the case, then both the partial and the fully colour-blind zones of the retina could be explained by reason

of smaller numbers of cones and greater numbers of rods in the colour-blind zones than exist in the centremost, full-colour zone. To spell this out, we must revert, again, to our original discovery that colour sensations are, ultimately, energy intensities and relationships in the centres of the brain. These sensation energy units are arrived at by integrations of huge numbers of nerve impulses. The only way in which the nerve impulse units can determine the integrative process that puts them together into sensations is by differences in the numbers of individual nerve impulses simultaneously delivered at the integrating psychons (inter-neuronic connecting tissue). A cone, let us say, can cause more of these impulses to be delivered simultaneously to appropriate psychons than can a rod. And many cones, simultaneously stimulated because closely placed together at the centre of the retina, can cause more nerve impulses to be simultaneously delivered than can a few cones, stimulated together in an outer zone of the retina, where cones are not so close together and there are more rods in between. Clearly, such an attempted description of the determinative differences between retinal colour impulses of origin would depend upon known facts only, and would not necessitate imagining chemico-structural differences between two or more types of cones, no indications of which have yet been discovered.

It remains to be seen, of course, how different types of integrations, with resultingly divergent sensation energy units, can be determined by quantitative differences in the numbers of nerve impulses entering into the integration, and this seems to be an issue requiring rather more neurological data than is at present available. But before this question can be approached, it is necessary to form some conception of the basic integrative mechanisms inherent in the structure and behaviour of the central nervous system. How many types of integrative relationships between two or more impulse groups can arise? And what is the nature of these various, possible, integrative relationships? Very little decisive neurological work has been done, so far as I know, along this line. My own psychological researches in feelings and emotion, however, have largely been concerned, during the last four years, with an attempt to study the integrative relationships responsible for the manufacture of pleasantness, unpleasantness, and four primary emotions, and to formulate these relationships in purely conceptual (i.e. non-physiological) terms. The close parallel between the four emotional primaries resulting from this analysis and the four primary colours postulated under modifications of the Hering theory have suggested to me the possibility that

motor integrations and sensory integrations may proceed according to identical principles. It may be worth while, therefore, briefly to summarize the four principles of integration upon which I have based my emotional primaries, and to present some of the tentative evidence which suggests the possible application of these principles to the fundamental problems of visual theory.

PLEASANTNESS—UNPLEASANTNESS AND BRIGHTNESS—DARKNESS.

Theories of pleasantness and unpleasantness have long been in virtual agreement[9] that the underlying cause of unpleasantness is to be sought in nerve impulse antagonisms, and that the ultimate physical basis of pleasant feelings lies either in mutual facilitation of impulses, or possibly in mere absence of nervous conflicts. My own psychonic theory of consciousness[8] offers a convenient corrolary to this doctrine, in that it attempts to demonstrate that notor consciousness is quite as basic a variety of awareness as is sensation. Conflicts of motor impulses in the motor centres of the central nervous system, therefore, according to this suggestion, are felt directly as unpleasant elements of motor consciousness, or unpleasant motations; while mutual facilitations of psychonic motor impulses constitute immediate pleasantness of feeling tone, or pleasant motations. In fact, I have suggested that pleasant and unpleasant motations, or affective tone, as it has generally been termed in the psychological literature, represent the simplest, as well as the typical, form of motor consciousness felt as a response to any environmental stimulus. The final common motor paths of the organism can scarcely be energized without some preliminary conflict or facilitation of impulses, and such psychonic conflicts and facilitations, according to my suggestion, constitute affective tone, ipso facto. In short, whereas introspectionists have been seeking motor consciousness in " innervation feelings ", or " movement feelings ", I have suggested that the omnipresent and obvious awareness of affective tone really represents motation, a category of consciousness correspondingly basic with sensation.

I wish now to suggest that the simplest introspectable sensations, like the most elementary motations, already mentioned, must consist of integrations of two or more nervous impulses at the central psychons. This necessity seems to follow, on the motor side, from the existence of a continuous discharge of tonic motor energy both to skeletal muscles and viscera, resisting the environmental forces of gravity, atmospheric pressure, etc. Phasic reflexes must encounter this tonic discharge, at or before the entrances to final common motor paths, and must form with it relationships of mutual antagonism or reinforcement. Simul-

taneously, on the sensory side of these tonic arcs, some sort of elementary sensory impulses must be going forward continuously; and these continuous afferent excitations may reasonably be supposed to ally themselves with, or to antagonize phasic sensory impulses of corresponding mode. But, for that matter, proof of the existence of a special continuous sensory background for each sense, in terms of which all transient sensory stimuli are perceived, is not far to seek. It has long been recognized that discriminable sensations represent *changes* in sensory stimulation, and not the sum total of stimuli applied. Thus, in nearly all modes of sensation, a given stimulus produces a sensation which represents the relationship of the stimulus to the existing afferent excitations in that mode. That is, an object is felt as warm only when its temperature is higher than the " physiological zero " of the body. The organism, of course, is continuously exposed, throughout life, to temperature stimulation, so that sensory temperature impulses must exist, at all times, with which new, or phasic temperature impulses must form sensory integrative relationship. Similarly, pressure sensations, kinaesthetic sensations, and olfactory sensations always represent integrations between a particular stimulus and the existing background of continuous afferent impulses from the type of sensory receiving apparatus appropriate to each sense.

Nor is the sense of vision an exception to this general rule. We have that curious, constant visual sensation known as " the intrinsic light of the retna " to serve as an everpresent background against which are perceived brightness, darkness, and colour. The " intrinsic light ", or seemingly constant gray sensation, seldom comes to the attention of the average individual, since his eyes are open during most waking moments, and the usual light stimulation from outside over-whelmingly obscures the " intrinsic light ". It can readily be observed, however, at any time, by shutting the eyes and protecting the lids from light stimulation. Its origin is obscure. L. T. Troland supposes that the stimulation arises from " a spontaneous decomposition of the photochemical substances or, at least, an automatic activity of the retinal apparatus ".[11] Mrs. Ladd-Franklin regards the intrinsic light as due to pressure (intra-ocular?) exerted upon the retina.[12] There is, furthermore, some evidence that the retinal cones are responsible for the constant visual sensation rather than the rods. Whatever its origin, this intrinsic light furnishes a constant flow of sensory visual impulses, with which transient visual excitations must be integrated in the formation of the more readily introspectable sensations of brightness and colour.

Rod vision has been associated particularly with brightness

and darkness sensations, since the rods seem to be our retinal mechanism for twilight vision when no colours can be seen. Besides the obvious structural difference in shape between the rods and cones, there also exists some observable difference between the type of bipolar cells with which rods and cones form synaptic connection, and[3] necessarily, therefore, some difference in the type of initial synaptic connection of rods and cones with the conducting fibres of the optic tract.[13] Here, at least, is a known rather than an hypothetical distinction between rods and cones, which readily lends itself to correlation with the distinction in function relative to colours vs. colourless vision. Just as certain reflexes of low order may, on the motor side, facilitate or conflict with the constant tonic motor discharge without in the least increasing or decreasing the initial tonic discharge itself, it may be supposed that afferent visual impulses of low intensity, received through the rod mechanisms of the retina, may either facilitate or impede the constant stream of intrinsic light impulses, without in the least altering the initial magnitude of the constant, intrinsic light excitation. I would suggest that the mutual facilitations of these two groups may be perceived as brightness, while mutual interferences may register in consciousness as darkness.

Such a suggestion seems to be in accord with a large number of known facts concerning the series of so-called black-white sensations. We know, for instance, that the sensation black is not only a positive experience, but that it can only occur when the eye is exposed to a surface or area less illuminated than that brightness to which the retina is at that moment adapted. Dark adaptation may, apparently, take place down to the level of the gray value of the intrinsic light sensation. Light stimulation below this threshold might well be supposed to set up afferent impulses of a frequency so low as to conflict with those producing the intrinsic light sensation: while stimuli of an intensity greater than intrinsic light stimuli, but less than stimuli producing the gray to which the eye might at any moment be adapted would tend, similarly, to set up afferent impulses calculated to reduce the total existing excitation by way of conflict and inhibition. Such an integrative relationship of sensory antagonism, rising at the central psychons to psychonic energy, or consciousness, might constitute darkness sensation. It may also be significant in this connection, that light so intense as to blind the eye, temporarily, also produces a marked sensation of blackness. It would seem that such overintense light, like the subliminal stimulus just considered, would tend to set up afferent impulses having an inhibitory or conflicting effect upon the intrinsic light impulse stream.

A parallel of integrative principles involved immediately suggests itself, not only with other modes of sensation, but also with the psychonic explanation of pleasantness and unpleasantness. In clinical and class work, during the last several years, I have obtained reports from students and clients with respect to their colour preferences, and with respect to the relative pleasantness of darkness and brightness. In general,—though my results are as yet far too few for statistical presentation,—I have found that there is some tendency, particularly with girls and women, to find brightness pleasant for its own sake, entirely aside from pleasant experiences which may have become associated with light. I have, as yet, found no corresponding tendency to find darkness, or even total blackness sensation unpleasant. There appears, however, with both women and males, a seemingly *marked tendency to experience unpleasantness while illumination of any visual field is being reduced, and to find the brightening of a visual field pleasant.*

This result, as far as it goes, is in accord with the above-mentioned parallel between the sensation of brightness and the motation of pleasantness, and the sensation of darkness and the motation of unpleasantness. If brightness is produced in consciousness by mutual facilitation between transient visual impulses due to a particular stimulus, and the constant intrinsic light excitations, it is, perhaps, likely that some corresponding facilitation should ensue between the transient, or phasic motor impulses following the light stimulus and the constant stream of tonic motor discharge previously occurring. Moreover, we might expect that it would be the process of increasing brightness, rather than greater brightness steadily maintained, which would yield the most noticeable crop of motor facilitation relationships at the motor psychons. The situation is not quite so clear in the case of darkening of the visual field and its apparently associated unpleasantness, for it does not necessarily appear that mere sensory inhibition between very low grade light impulses and the intrinsic light stream would carry over to the motor side of their respective arcs, in sufficient strength to antagonize the constant tonic motor discharge. If we assume, however, that the total of intrinsic light and facilitating afferent impulses are represented by a constantly equal volume of tonic motor discharge, then any diminution on the sensory side must be reflected by corresponding reduction of motor discharge, possibly in the nature of conflicts or inhibitions. However, no exact parallel between actual brightness or darkness and actual pleasantness or unpleasantness of any given stimulus is to be expected, because of the complexity and previous conditioning of the central nervous system. The only exact parallel suggested by our present

discussion is the parallel between the integrative principles used to form the simplest motations of pleasantness and unpleasantness, and the integrative principles responsible for the simplest visual sensations of brightness and darkness.

Domination-Submission and Blue-Yellow

We now come to a consideration of the four integrative principles forming the neurological basis for four primary emotions which seem to accord rather closely with objective observations of human and animal behaviour. It should be noted, in the first place, that all four principles of motor integration herein suggested result in ultimate facilitation of the total motor discharge, and so produce accompanying pleasantness. But all four principles, also, involve initial changes in the volume of tonic motor discharge itself, a factor which does not enter into the simplest type of motor facilitations and conflicts supposed to underlie pleasantness and unpleasantness. Intrinsic pleasantness, then, will incidentally accompany successful consummation of all four types of emotional integration, though in varying degrees; while unpleasantness must occur incidentally to the thwarting, of blocking of any emotional integration by antagonistic motor impulses.

Domination is the first emotional, integrative process to be considered. A clear example of domination behaviour may be noted in an infant's reaction to the experimenter's attempt to take away from it a rod or stick which it has grasped in its hands. The baby's grip tightens in proportion to the pull exerted by the experimenter; and if this process be continued gradually enough, the child will suspend its entire weight from the rod, rather than let go of it. There seems to occur a progressive reinforcement of the tonic motor discharge into grasping muscles of hands and arms, the grasping posture evidently representing part of the natural tonic set, or "reflex equilibrium"[14] of the organism. The tonic discharge is increased, in domination integrations, for the purpose of overcoming an antagonistic motor stimulus, and compelling the motor impulses that seek an opposite final path of discharge to follow the tonic channels. When this domination of antagonistic motor impulses has been accomplished, there is, of course, a facilitation of the total previous motor outflow, over the final common paths, to appropriate muscles. Domination, then, as a suggested primary principle of integration of motor impulses, may be defined as an *increase of tonic motor discharge for the purpose of overcoming and directing an antagonistic impulse.*

Submission as an emotional integrative process is exactly the converse of domination. While domination is the backbone

of egoistic, appetitive, or self-seeking emotion, submission is the mainspring of love or self-giving emotion. While domination, therefore, is based upon an increase of ego, or tonic motor discharge, submission consists, primarily, of a diminution of tonic out-flow. Such diminution, in the case of that type of behaviour which I have defined as submissive, is brought about for the purpose of shifting the tonic outflow from its native efferent paths into channels determined by the phasic stimulus responses. Watson has shown that this sort of response is an inherent one, by demonstrating its presence in the very young infant, under the generic term "love".[15] Watson found that stroking sensitive zones of the infant's body, and tickling its hands and feet were followed by cessation of crying, general relaxation of muscular tension (decrease of tonic discharge), and opening of hands and holding up of feet to be tickled (switching of reduced tonic energy into paths dictated by the phasic stimulus), together with laughing and cooing. Submission, as a primary principle of motor integration may be defined as a *decrease of tonic motor discharge for the purpose of yielding to and being directed by an allied impulse.*

The clearest results I have so far obtained in the colour preference studies before mentioned show a marked tendency on the part of male subjects to prefer a bright, saturated blue, as first choice among colours of the spectrum. Male subjects also, with almost equal consistency, give pure spectral yellow as their last choice, or least liked colour. Many male subjects have expressed marked disgust and repugnance for yellow. Women subjects, on the other hand, very frequently name yellow as a first choice, while less than one per cent. of my female subjects, so far, have given blue as their favourite colour. Green seems to be rather a close second to yellow as a first choice with women; but there is very much more scatter in the female preferences, various intermediate colours, and less saturated tints frequently appearing at the head of the list. It is often very hard to get women to name the colour they like least, and often impossible to find a hue they are willing to say they positively dislike. "I like all colours", is a frequent response. Dark blue and dark red, however, are frequently named by women as least liked. On the whole, I may report the general tendency of results at the present writing to be a marked male preference for blue and dislike of yellow; with an almost equally clear liking for yellow and green on the part of women subjects (whether these primaries are names as unequivocal first choices, or not), and a less marked female tendency to like dark colours least, especially dark blue and dark red.

These results—which appear much more significant when coupled with clinical clarification and introspection—first suggested to me a possible psycho-neural connection between the colour blue and the emotion of dominance, and between the colour yellow and the emotion of submission. Males, as a sex, are unquestionably more dominant than women; while women, as a sex, appear to possess almost a monopoly of pure submissive emotion. From personal cross-examination of male subjects, I soon became convinced that blue appeared to represent to them a sort of natural picture of dominant feeling, while it seemed even more evident that yellow was felt to be a weak, yielding sort of colour. Of course, in this type of emotional analysis, one has to exercise extreme caution in separating learned, or associated colour meanings from a priori or naïve reactions to the colours themselves. Only in clinical cases studied over a period of years do I feel satisfied that this analytical precaution has been sufficiently observed. But in a very few cases, I feel reasonably sure of the accuracy of the results, though less certain, of course, regarding their significance.

There are one or two general facts of some interest in this connection. Verbal convention has long associated the colour yellow with anti-dominance, or cowardice. To be " yellow ", in common parlance, means to submit to some person or natural force when such person or force might be dominated. Submission as the greatest power one human being can possibly exercise over another is understood only by love-trained women, seldom by males. The current male standard, therefore, calls for dominance as an end in itself, and, in fact, as the most desirable of all ends. A male who deliberately abandons this standard is regarded as " yellow " though perhaps a woman, in similar circumstances might only be referred to as " weak ", since it seems to be unconsciously recognized that women live by emotional standards peculiar unto themselves. In short, not only is pure submission despised and rejected among males, as a standard of conduct, but also real ego-weakness, or fear (which is something quite different from submission, being composed of thwarted compliance[16]) is inextricably confused with submission. It is interesting, at least, that the colour yellow has come to represent this perverted conception of submission in the male-made colloquialisms of the market-place.

Yellow, on the other hand, has always been the imperial colour of the Chinese, a people whose upper classes have been civilized longer than any other existing nation. Moreover, it is commonly recognized by those most conversant with Chinese philosophies, social customs, art, and religion, that the Chinese civilization

has been built, primarily, upon an emotional response of submission. Wholly submissive attitudes towards parents, officers of the law, ancestors, and especially toward the Father of His People, the Emperor, are to be found inculcated into Chinese thought and life in every phase, not as mere matters of expediency but as basic virtues of character. Some of the ablest Chinese teachings have regarded the Emperor as fated to rule because empowered by divine decree with greater gifts of submission to the needs of his four or five hundred million children than any other living mortal. Curiously enough, ancient Chinese history seems to show that one or more dynasties of Supreme Rulers actually selected their successors upon this basis, more or less in despite of self-interest as represented by their own personal descendants. In general, the Chinese appear to have sought appetitive satisfactions through a mechanism of submission which is quite unique in the world's history. That such a people, for thousands of years, have regarded yellow as a sacred and all powerful colour, suggests at least, the possibility of some psycho-neural association between yellow sensation and submission emotion.

Formulation of a visual colour hypothesis based upon the above suggestion is not difficult, nor is the resulting theory complicated by a necessity for the elaboration of imaginary substances or new types of mechanisms. The known facts of the matter seem to be that there exists a constant stream of afferent visual impulses, producing the intrinsic light of the retina; that different wave lengths of stimulating light produce quantitatively different batteries of transient visual impulses, corresponding to different colour experiences; and that the intrinsic light impulses must be integrated, according to some definite set of integrative principles, with the transient colour impulses. The only theoretical part of the proposed schemata, therefore, consists of the conceptual formulation of four basic principles of motational integration, and the subsequent extension of these same principles to the sensory visual integrations which we know must occur prior to the appearance of visual sensations in consciousness.

If we apply the dominant principle of integration to the sensory manufacture of blue consciousness, we have first to observe that the wave-lengths of blue light are shorter than those of any other primary colour stimulus. Thus we may assume that a more intense stimulation of retinal cones results, with each cone energizing close to the maximum number of individual nerve fibres with which it is directly connected. The dominant factor in a final sensory integration evidently would be the transient stimulus, rather than the constant, intrinsic light; thus reversing the roles played,

on the motor side, by constant tonic discharge and transient antagonistic stimulus. This is a purely logical, rather than factual assumption, and is based only upon the supposition that, in emotions, it is the self (or constant motor discharge) that is acting upon the environmental stimulus, while on the sensory side it is the environment that is acting upon the self (constant afferent excitations). If this be the fact, it is easy to see how the most intense visual stimulus within the modal intensity series, or octave, would be best qualified to overwhelm, or dominate the entire existing flow of intrinsic light impulses. Blue light seems to be the shortest wave length of the spectral series, so far as its relationship to the retina goes, since still shorter wave lengths begin the colour circle all over again by mingling red, the longest wave-length colour, with blue sensation, to produce violet.

Moreover, just as there exists a circular mechanism composed of proprioceptive muscular reflexes by which the constant tonic motor discharge can be increased or decreased in effecting integrative relationships with phasic motor impulses, so we find in the retina itself a mechanism by which the constant stream of intrinsic light impulses might be altered at the very inception of a transient light stimulus. All end organs of the retina transmit their impulses across an initial set of synapses in the external molecular layer of the retina, to neurons of the second order whose cell bodies lie in the internal layer. Some of these second order neurones spread the impulse laterally, while others conduct directly to a third set of synapses with the so-called " ganglion cells " of the retina. It is apparent that the laterally conducting cells of the second order may, when excited, effect all the afferent fibres leading into the optic tract; and some of the fibres thus affected must be carrying continuously the intrinsic light impulses. Thus it would seem that there is a possibility of summation or inhibition of the intrinsic light stream, at the very beginning of the conduction of each transient colour impulse toward the brain. That is to say, each light stimulus may increase or decrease the total intrinsic light excitation, at the same time that the transient impulses proceed as a separate unit toward the central synapses, where, eventually, they must form their typical, or definitive relationship with the intrinsic light stream.

If, then, a blue light stimulus, with its short wave lengths causes an initial reduction by way of inhibition in the intrinsic light volume, and later forms a dominant junction with the unit mass of intrinsic light impulses, compelling the latter to follow the " blue " path toward further integrations at higher brain levels, we might logically characterize the sensory event thus described

as visual domination of the organism by an intense stimulus. For the sensation blue, thus analyzed, would consist of diminution of the visual self (constant gray sensation), by an intense, or dominant light stimulus, with the dominant stimulus overcoming and directing the self at their integrative juncture. I have tried to show elsewhere that a stimulus perceived as dominant always elicits a dominant emotional response.[16] In the absence of individual reconditioning, then, we might expect that the colour stimulus blue would call forth an emotional tinge of dominance, which would be most acceptable and pleasant to males, and not so pleasing to women subjects.

When the final juncture occurred between blue stimulus impulses and intrinsic light impulses, some facilitation would, of course, inevitably result. This would contribute to the blue sensation whatever brightness it possessed. Yet, it is to be observed that the dominant form of integration seems to involve some mutual interference and possible diminution of the absolute value of one or both component impulse groups, prior to their final unification. Thus, it would not be expected, if the suggested analysis of blue sensation is correct, that blue would possess a maximum brightness. Such logical expectation is, in fact, in accord with experimental findings. Blue is not, under any conditions, the point of maximum brightness in the spectrum.

Yellow, on the other hand, contains the spectral area of greatest brightness to the light-adapted eye. Following our above suggested schemata, we might suppose that the sensation yellow is formed by an integration in which the yellow visual impulses submit to the visual self, or constant, intrinsic light stream. Yellow light, of course, is composed of much longer wave-lengths than is blue light. Yellow light, in fact, is to be found within the long-wave half of the spectrum, and it seems, therefore, to follow that the ensuing excitation of retinal cones is less intense. If we may assume, then, that these feebler impulsions are of requisite volume initially to increase rather than to diminish the intrinsic light stream, by way of the circular nerve fibres of the retina or some other appropriate synaptic mechanism, the suggestion follows that the yellow impulses may be of proper relative volume to yield to and may be directed by the constant visual impulses at their definitive juncture. In such a relationship no mutual interference or conflict of impulses could occur at any stage, and a maximum of mutual facilitation should result. According to the brightness theory suggested above, this maximally complete alliance relationship at the integrating psychons should produce the maximum brightness of the spectrum; which, in fact, it does.

Were the sensation yellow manufactured by the above suggested formula of integration, it must represent the sensory outpicturing of a submissive stimulus, just as blue sensation might be supposed to represent visual perception of a dominant stimulus. My emotion studies clearly indicate that submission emotion is evoked by a submissive stimulus.[14] Therefore, submissive emotion should follow perception of yellow colour stimulus, unless the naïve emotional reacton has been altered, in any individual subject, by associative reconditioning sufficient to obscure the natural effect. In such spontaneous functioning of the nervous system according to its innate formuli, we might find adequate explanation of an unlearned masculine dislike of yellow, a female toleration of the colour, and the Chinese veneration of yellow hued ceremonial vestments and banners.

When the intensity of illumination of the spectrum is increased, without change in the wave-lengths of any component light, the hues of the long-wave half of the spectrum change to yellow, and then to gray; while the colour sensations produced by the short wave half of the spectrum assume a bluish tint, and finally shift into black-white sensations. (Green as an exception to this rule will be noted at a later point in the present discussion). All colours, when thus transformed into yellow and blue, possess great brightness but very low chroma. On the other hand, if the intensity of light be similarly diminished, spectral colours change to red, green, and violet, all very dark and of varying, though low saturation. These facts seem closely in accord with the fundamental premise of this paper, namely that *intensity of stimulation of the cones is the differential stimulus factor upon which integrative manufacture of colour sensations is based*, rather than specific effects of different wave-lengths of light upon different photo-chemical substances.

Also, these phenomena seem to offer evidence that the "blue-yellow" zone of the retina may be colour-blind to red and green light merely because a sparse allocation of cones, such as that existing in the blue-yellow zone, is not capable of generating sufficient volume of nerve impulses to integrate definitively with the intrinsic light stream except when the few cones simultaneously stimulated are energized to the maximum of two nodal points, one capable of dominating the intrinsic light energy and the other of submitting to it. For, as we have seen, if any retinal cone is stimulated with maximum intensity, whatever the wave-length of the light used, it gives blue sensation, and finally simply brightness; while any cone can be made to produce yellow sensation by supplementing the low intensity of long-wave stimuli

up to the point where they naturally submit to, and completely blend with the intrinsic light. The marked access of brightness and diminution of chroma, also, as the intensity of stimulation is increased, seems in close accord with the idea that brightness is the awareness of simple facilitation of the intrinsic light sensation. After this constant visual stream had been initially increased or diminished to its extreme limits, only facilitation could occur upon juncture with a specific light stimulus, and the integrative relationship which has been suggested as the basis of colour consciousness would be expected to disappear, just as colour sensation does, in fact, disappear, at sufficiently high and low intensities of stimulation.

Compliance-Inducement and Green-Red.

Compliance emotion, as its name implies, consists of moving the self to adjust it advantageously to the stimulus, rather than attempting, as in dominant response, to move the self for the benefit or to the advantage of the stimulus. Compliance shares with dominance the element of maintaining tonic motor discharge in its own, ego-determined channels. On the other hand, compliance shares with submission the factor of diminishing the tonic discharge to give free access to the motor impulses representing the stimulus.

Compliance emotion may make a virtue of necessity, and refrain from attempting to move or dominate antagonistic impulses which are stronger than the total tonic reserve energy of the organism. The infant, Watson tells us,[15] does not attempt to attack or remove the source of a loud sound, or the experimenter who jerks the bedclothes from under him. The child complies, as best he can, by crawling away, or by clutching for fresh support. He makes no attempt to move the stimulus, but accepts it without resistance, and moves himself in the ways natural to his native reflex equilibrium to bring about an adjustment to the stimulus which is most favourable to himself.

On the other hand, an art connoisseur may express a more active and positive type of compliance by moving himself in such a way as to permit a fine painting to have its maximum effect upon his organism through his sense of vision. He does not purpose to move the picture in any way, or to change it; yet his painstaking readjustment of posture is not for the sake of benefitting the object of art, but rather to benefit himself through enjoyment of the stimulus. The adjustment is designed to permit the discharge of as much of his tonic energy as possible through its wonted channels, simultaneously with the discharge of a max-

imum motor excitation set up by the painting and its associations. *Compliance*, as an integrative motor principle, *may be defined as a decrease of tonic motor discharge for the purpose of permitting an antagonistic phasic impulse to find outlet over its own path of discharge.*

The amount of pleasantness experienced by a majority of subjects in successful compliance responses is great relatively to the pleasantness reported as accompanying other emotions. Of course, in its passive aspect, compliance is characterized chiefly by decrease of unpleasantness and by relief But positive compliance, most commonly recognized in the mild, pervasive feeling of well-being following a good meal, is exceedingly pleasant to most subjects. Moreover, aesthetic pleasure, regarded by many individuals as the very acme of enjoyment, is largely composed of compliance; in fact, the greater the admixture of dominance present, the less delicate and exquisite is the esthetic satisfaction. All pleasantness found in merely viewing beautiful objects, or landscapes, with no wish to possess the object viewed, may be classified as compliance, and these experiences are found extremely enjoyable by a great variety of people in all walks of life.

The unpleasant strain, anxiety, and fear which often accompany attempts to comply with dangerous and threatening forces and situations, do not spring from the successfully compliant aspects of these responses, but from attempted compliance that is partially defeated, and from dominance that is foolishly spent in support of compliance, and so, also, becomes partially or completely defeated. Successful dominance defeats the attacking stimulus, and successful compliance harmonizes the dominant energy of the organism, during the struggle, with those parts of the stimulus which must be accepted as they are, without wish to change them. Were there sufficient compliance present in any struggle, all unpleasantness would be avoided, and a great deal of pleasantness even, would be experienced in the sheer smoothness of adjustment in attack. These are compliant satisfactions.

The evidence for associating colour with the emotional responses of compliance is not as easy to obtain as in the case of blue-dominance, or yellow-submission; principally for the reason that compliance, as above outlined is not a conventional concept, and subjects of both sexes seem to find it difficult to associate the feelings of successful compliance from those of partially defeated compliance and dominance. The colour green, as I have already mentioned, is a frequent first choice among women subjects. In the course of my studies in colour-preferences, to date, green has never been placed last on the list by male subjects, nor have

men ever expressed for green a positive dislike such as they frequently aver towards yellow. Many subjects, notably women, report that green is " the easiest colour on one's eyes ", or that " green is a restful, harmonious colour ". There is, moreover, a higher total pleasantness score for green, so far, than for any other colour, nearly all subjects placing it fairly high in pleasantness value.

Clinical analyses, properly checked and safeguarded, reveal, first and foremost, a very strong association between " nature " and the colour green. It is thought of as " the colour of growing things ", " the spring colour ", or " the most natural colour there is ". Which means, evidently, that green has been seen more frequently, and in larger masses than any other colour, and so has become more closely associated with its conditional stimulus than has almost any other hue. But, in addition to this learned ideational meaning of green, there appears to exist, in many subjects, a naïve emotional feeling of ease, relaxation, harmony, and mild pervasive pleasantness and well being associated with green sensation. These emotional experiences, while seldom realized as " compliance emotion " by subjects unfamiliar with the concept, seem exactly to constitute successful compliance as above outlined. In fact, I may say that I have based my formulation of the concept of compliance as an integrative principle, to a considerable extent, upon the very reports of compliant emotion just mentioned. It seems to me, therefore, on the whole, that there is considerable indication, in my present results, of the possibility that there exists some innate, psycho-neural connection between green sensation and compliance emotion.

The application of compliance, as an integrative principle, to an attempted postulation of the manufacturing formula for green sensation is made easy by the close connection of this formula with the submission formula for yellow. Spectral green light is composed of wave-lengths next in series to the wave-lengths of spectral yellow, the green waves being slightly shorter than the yellow. It will be remembered that we supposed yellow light to be of such a stimulation intensity that it increased, initially, the afferent intrinsic light stream, which then became of just sufficient volume to draw the yellow impulses into its own course, at the junctional synapses. We may now suppose that the green stimuli, being of next greater intensity to the yellow, result in a volume of nerve impulses which increase the intrinsic light excitation initially, just as do the yellow impulses. But we must further suppose that the green impulses, being greater in volume than the yellow, turn out to be approximately equal, at the junctional synapses, to the initially enlarged intrinsic light

stream, and so form a cooperative juncture with the latter, rather than forming the submissive juncture entered into by the yellow impulses. The green excitations would then pursue their own course, which would nevertheless be harmonized, at common psychons, with the path of the intrinsic light stream, producing mutual facilitation within these conjunctive centres.

Such an integrative picture of green sensation might be expected to yield an amount of facilitation nearly as great as that produced by the submissive type of juncture hypothecated as a basis for yellow sensation. The intrinsic light stream would be increased, and it would be, to a large extent, synchronized with the green stimulus impulses, though not quite as completely as the yellow excitations which, in submissive relationship, must merge themselves completely in the intrinsic light stream. If, then, brightness sensation is psychonic facilitation, spectral green should prove to be, as in fact it is, nearly as bright as spectral yellow.

According to the integrative formula suggested, the lower the initial value of the intrinsic light volume, the greater should be the increment of facilitation produced by green light as compared to the increment of facilitation caused by yellow light. For whereas the simple, initial addition to the intrinsic visual stream, which both yellow and green impulses have been supposed to produce, would not be interfered with by an unusually low intrinsic volume prior to stimulation, no matter how low this prior volume might be, the yellow impulses might find a submissive juncture with too low a total volume of intrinsic impulses partially impossible to effect. The green type of cooperative integration, on the other hand, might just as readily be made with low total volumes of intrinsic excitation, as with greater volumes of these same impulses. That is to say, only part of a battery of yellow impulses might be able to submit to a very small intrinsic light stream; whereas all green impulses, no matter how voluminous, should find no greater difficulty in cooperative juncture with a small intrinsic stream than with a large. This theoretical result harmonizes very well, apparently, with the so-called Purkinje phenomenon, in which it has been found that the maximum brightness of the spectrum shifts from yellow to green when the eye is dark adapted and the intensity of spectral illumination is decreased. According to the above suggested schemata, the yellow, submissive type of juncture should begin to fail when the intrinsic light stream prior to stimulation is low, and the intensity of yellow stimulus is thereafter reduced below the point where its initial increase of the intrinsic stream compensates for this low prelim-

inary volume sufficiently to permit total submission of yellow impulses to the intrinsic stream.

The fact that green does not change hue, as the intensity of illumination is increased, until it finally passes into completely colourless sensation, also seems easy to account for on the integrative principles suggested. A cooperative relationship of integration, once established, should not be altered by smultaneous increase of both factors integrated, except to increase the total amount of facilitation (brightness). If increase of intensity of green wave-length stimulus reached the blue intensity before all chroma was lost in brightness, then initial diminution of the intrinsic light stream might be expected to replace the initial increase supposed to result from normal green stimulation; and in such case we might expect that green would turn to blue, before giving way to simple brightness. But it seems in accord with the known relationships between the number of discriminable hues and the wave-length intervals of this portion of the spectrum to conclude that this would not be likely to occur.

The unusual amount of pleasantness experienced by most subjects in viewing the colour green corresponds closely with the high degree of enjoyment taken by these same subjects in the pleasures of compliance. This emotion is the one primary that requires no especial effort of initiative, once it is learned—simply a flexible harmonization with environment, whatever that may be. It is, therefore, within the reach of everyone, and is, to a certain extent, forced upon everyone by defeats in the struggle for existence. Moreover, compliance in the form of esthetic appreciation of nature and art is an emotional attitude that is commonly in high repute, sanctioned and even subsidized by the conventions and institutions of civilization. Love, on the other hand, which contains the maximum amount of submission is frowned upon and prohibited, in every way possible, by occidental society. The comparison, therefore, between the true, or naïve pleasantness value of submission and that of compliance is very difficult to make with average subjects. But passionate (submissive) love forms such a small part of the lives of most "civilized" people, that it seems safe to say that the average pleasantness of submission (that is, averaging together subjects of both sexes), is just about as far below that of compliance, as the average pleasantness value of light is below that of green. This result, it must be noted, comes from a learned motor inhibition toward submissive behaviour; so that whereas green and compliance receive just about their normal pleasantness value, yellow and submission are rendered far less pleasant than is their psycho-neural right, by habitual motor blockage.

That the greatest natural possibilities for intense pleasantness lie in submission, just as the greatest brightness is to be found in yellow sensation, cannot be doubted if one observes the uninhibited enjoyment of women in love relationships of both passionate and maternal types. It may, perhaps, prove significant that many women subjects, capable of intense submission emotion, find especial pleasure in golden-yellow colour sensation.

Inducement emotion constitutes the element of love initiative. Just as compliance is a supplementary emotion to dominance in appetitive or ego-seeking behaviour, so inducement acts as the natural ally to submission in self-giving emotion. Before one human being can give himself to another (submission), he must induce that other to accept the gift; and that is the emotion of inducement properly used in a completed love response. Like compliance, however, inducement may stand alone, without its natural ally, and may thus be prolonged indefinitely. Unfortunately, also, inducement in the wrong relationship to submission results in seduction or "lust", and inducement used without submission in the wrong relationship to dominance and compliance produces deception, treachery, hypocrisy, and the various so-called "criminal" attitudes.[17] It is especially important, therefore, to understand that inducement, by itself, is not responsible for the unpleasant aspects of these emotional mixtures, and that it in no wise partakes of the anti-social nature of any of them.

Watson has found[15] that inducement forms part of the love behaviour of very young children. An infant may hold out its arms spontaneously, not as a result of stimulation or tickling by the experimenter, but in order to induce mother or nurse to administer such stimulation. Watson found, in fact, that a child might spontaneously hug its mother. In adult life, the nature of inducement stands out just as clearly. A mother, for instance, induces her child to take a bath by putting her own hand in the water to show that a pleasant feeling results from immersion, or she may place a bath toy in the basin or tub ready for the child to play with in his own way, while being bathed. Thus, the mother, acting as inducer, increases her own tonic energy (or, as the phrase goes, "makes an effort"), and directs it into paths selected by the object of inducement, the child. This doing something for the benefit of another person is identical with the same element to be found in submission emotion; but, in the case of inducement, the motor ego (tonic discharge) is increased in order to take the initiative in entering action paths determined by the other individual, instead of being diminished in order to be attracted, or drawn into actions benefitting the other.

The most obvious case of adult inducement is that of the chorus beauty who undresses herself, and moves her body in a series of difficult and complicated postures, dictated, as far as possible, by the sex nerves and receptor mechanisms of the spectators, in order that these persons may be induced to release a flood of motor discharge, within their own bodies, into the same channels opened up by the inductive stimulus. Neither the fact that this inducement is used by the girl for ultimate appetitive purposes, nor the fact that the spectators are initially dominated to the extent of an admission fee, should be confused with analysis of the true inducement reaction itself. The experiencing of inducement emotion, active on the girl's part, and passive on the parts of the spectators, is what the audience pays for, and it is also that for which the fair performer is paid. This particular example, moreover, seems to be an instance of an extended inducement experience which does not contemplate or achieve ultimate submission (giving of selves to each other).

Inducement, as a principle of motor integration, may be defined as *an increase of tonic motor discharge for the purpose of gaining an outlet through the path of discharge of an allied, phasic impulse.*

The colour red has been emphasized, in various brands of psychoanalytical teachings, as symbolical of sexual passion. In my own colour studies, I have found considerable justification for associating red sensation with the *seeking* aspect of sex emotion (even when this response is not properly organized to constitute love). Red stands, so far, in the colour preference table, as second choice to blue among male subjects. It seems to carry with it, so far as clinical data reveal, a certain naïve emotional tinge of virility, love or social leadership, and often exhilaration and sex supremacy and conquest. I have so far found no evidence that red is associated with sex passion because sex exitement carries heat sensation, heat is associated with flame, and flame is though of as red, although Dr. J. B. Watson told me some time ago, in conversation, that he accounted for the sexually symbolic meaning of red in that way.

I have found four or five subjects, all but one males, who report that they actually " see red " when they are " terribly angry ". Questioning in every case, without exception, revealed the fact that the subject could never remember " seeing red " when " mad " or " furious " at an inanimate object, but that the experience seemed to occur only when angry at another person. (In one case, however, a rebellious Saint Bernard dog was thought to have made the owner " see red ".) I am by no means satisfied as to the nature of this curious phenomenon; but it does carry a suggestion

that anger at a person or animal is associated in some physiological, or wholly unconscious way, with red sensation. Were this the case, it would constitute rather important evidence of the existence of some unlearned association between red and the emotion of inducement; for I am quite satisfied, as a result of analytical studies, that the curiously malicious character of the anger response directed against another human being is produced by thwarted inducement (whereas other forms of rage may contain only over-intense dominance).

Accepting the suggested connection between red sensation and inducement emotion, then, for whatever it may be worth, we may attempt to apply the integrative formula of inducement to the sensory analysis of red. The light waves which act as adequate stimulus to the red sensation are the longest in the spectrum. We might assume, therefore, that the resulting intensity of stimulation had reached a low point in the spectral series, corresponding to the high point of intensity of blue stimulation, and productive, therefore, of the same initial inhibitory effect upon the intrinsic light stream that we have assumed to be exercised by blue stimuli. With intrinsic impulse volume thus reduced, the red impulses might force their way into the intrinsic light stream path. This type of juncture, with low volumes of impulses entering the eventual, facilitating relationship, could not be expected to result in maximal brightness, according to the integrative theory under discussion, as, in fact, it does not. Inductive integration, however, like dominant integration, might be expected to be very positive and definite in the establishment of its relationships, since the stimulus impulses constitute active agents, increased in volume as compared to the intrinsic light stream, which they join under their own power, as it were. Perhaps this assumption might serve to account for the known fact that the spectral blue and spectral red are the most saturated hues of the spectrum.

Finally, it may be noted that complementary colours may very readily be described by means of the integrative theory proposed. If two diametrically opposite types of integration are attempted, simultaneoulsy, with the same stream of intrinsic light impulses, by two opposite types of stimulus impulse volumes, it would certainly seem that the equal and opposite influences upon the intrinsic light impulses must cancel one another out, leaving the double volume of stimulus impulses to form a simple, uncharacteristic juncture with the intrinsic light stream. Such juncture would, of course, result in marked facilitation, but would permit no colour sensation to result. Exactly opposite types of integration, therefore, would produce brightness sensation,

but no colour, which is the effect arrived at by all pairs of true complementary colours. The same effect might be anticipated, under this theory, whenever the intensity of a colour stimulus fell below that of the intrinsic light stimulation. As a matter of fact, it has been discovered in practical colour photography that the intrinsic light of the retina has a tendency to obscure colours at low intensities of illumination.

Now one of the difficulties that has beset the path of colour theorists who have postulated one photo-chemical substance for blue-yellow, and another photo-chemical substance for green-red, has been the fact that pure spectral green and red, though forming convenient and logical starting points in the colour rectangle, for various reasons, do not constitute truly complementary colours. In fact, their simultaneous presence on the retina produces yellow. This seeming whimsicality of primary colours led Hering, finally to choose blue-red (really in the purple series), and blue-green, as his photo-chemical primaries. These colours are complementary, surely enough, but are of little use in satisfying the various other requirenemts of colour vision theory. Mrs. Ladd-Franklin finally cut the Gordian knot, so far as photo-chemical theories go, by boldly manufacturing, in imagination, a sort of egg-cell like differentiation of yellow substance into daughter substances of green and red, with the supposition that both the offspring had to join with the male parent, blue substance, if the grandparent substance, black-white were to be reassembled. On the other hand, according to this ingenious theory, green and red substances released simultaneously, would unite (chemically?) again, forming yellow substance. This yellow substance must then, I suppose, stimulate the retinal nerve endings in its distinctive way, setting up afferent impulses appropriate to the final sensation, yellow. We should then have the same basic problem to solve that we had in the first place; i.e. what impulse relationships constitute the sensation yellow? And we might answer that question in the manner suggested in this paper, or in some more satisfactory way.

If, however, we do not choose to avail ourselves of the ample and convenient supply of imaginary photo-chemicals just mentioned, for the purpose of mixing our colours in the retina, we have an equally logical, and perhaps a somewhat more realistic method available under the integrative principles above proposed. For it may be noted that while the principles of dominant and submissive integrations are exactly opposite, one to the other, the integrative principles of compliance and inducement are not, in their entirety, opposed. It is true that compliance is based upon a relative

decrease in the compliant element while inducement calls for an increase in this same element, and, so far, the principles are opposites.

But, in compliance relationship, the stimulus accomplishes its harmonization with the sensory self merely by remaining in its own path, and this cannot be said to be opposed completely, to the integrative procedure of entering the path of the intrinsic impulses. The opposite of entering the path of the intrinsic impulses would be to compel these impulses to enter the path of the stimulus, which is the second part of the domination principle.

We note, then, that the inducement principle finds an opposite for its first phase (increase of stimulus) in compliance integration (decrease of stimulus), and that it finds an opposite for its second phase (entering intrinsic impulse path) in domination integration (compelling intrinsic impulses to enter path of stimulus). A mixture of all three integrative principles, inducement, compliance, and domination would be required to cancel one another out and produce simple facilitation; just as we know, in fact, that a mixture of all three colours corresponding to these three principles, red, green, and blue, is required to abolish colour sensation and to leave only brightness. Mixture of inducement and compliance alone (red and green), would result, most probably, in no relative change in stimulus volume, since the opposite first phases of these two integrative principles might be expected to cancel one another. But the second part of inducement (entering the intrinsic path) might be expected to become the controlling factor, since it is the only positive one, in its conflict with the second part of compliance (merely remaining in statu quo). A yellow (submissive relationship) combination of impulses should result rather than a red relationship, since the stimulus had failed initially to be relatively increased, and the red stimuli, without such increase, being originally weaker than the yellow, might prove to hold the same proportionate relationship to the intrinsic stream that yellow impulses would hold after initial relative decrease. The entire phenomenon, in short, is one of relative proportion between stimulus impulse volume, and intrinsic light volume; and the relative proportion productive of yellow sensation may just as readily result from combination of red and green integrative principles as from the adequate yellow light stimulus itself. Thus we might explain the behaviour of red and green in producing yellow, without recourse to any supplementary mechanisms whatever, over and above the integrative principles first postulated. Such a simplification and unification of visual theory seems, at least, worth attempting.

The above discussion of the mingling and interaction between the four integrative principles proposed suggests that a graded

series of integrative relationships probably exists, in which the "primaries" merely represent nodal points, where distinct and clear-cut shifts of integrative principle can be detected. Such a continuous series of integrative relationships would be exactly in accord with the continuous colour series of the spectrum, on the one hand, and with the continuous series of indistinguishable emotional tones, on the motor side. "Primary emotions" and "primary colours", thus defined, should escape the stigma of artificiality with which physical scientists, statisticians, and others are apt to condemn any definite formulation of admittedly diverse phenomena into a small number of supposedly basic elements.

The scope of this paper is not sufficient to discuss at requisite length the phenomena of positive and negative after-images of complementary colours, and simultaneous induction of identical or complementary colours. Suffice it to mention, in passing, that the data of neurology offer a rich assortment of diverse rules of behaviour of nerve impulses at the synapses, in terms of which it should be a comparatively simple matter to account for these colour phenomena, once we concede that the manufacture of colour sensations is an integrative affair. After discharge, for instance, might account for positive after-images; but we also have, very possibly, the phenomena of "immediate induction",[18] and irradiation and central spread of reflexes to utilize. For contrast colour effects, we might examine the applicability of "successive induction"[18] "rhythmic alternation", "post inhibitory rebound", "electrical reversal", or some adaptation of "postural reversal" to sensory integrations.[19]

With photo-chemical theories of vision we always have a difficult time trying to stretch a very few, imaginatively endowed, retinal substances to cover a multitude of colour phenomena. With an integrative theory of vision, our chief difficulty lies in selecting intelligently the pertinent principles of nerve-impulse behaviour from a great mass of painstakingly prepared material furnished us by the physiologists. After such a tentative selection, moreover, our experimental task, as psychologists, in testing the accuracy of our selection, must be kept in very close alliance with the sound and dependable laboratory results of the neurologists, if we hope to demonstrate the reliability of our psycho-neural theories as physical facts. In my own opinion, the only possible future for psychology as a recognized and independent science, lies in this return to the facts of earth, despite the fascinations of sexual flights through the fictional clouds of psycho-analysis, and the intellectually bourgeois pleasures of wayward floating through the etheric seas of statistical truthlessness. The integrative theory

of vision suggested in this paper does not in the least pretend to have effected a complete alliance with neurological data or terminology; it is presented only as a trustful approach toward such a desirable union. The specific nerve impulse mechanisms of the four conceptual principles herein formulated have yet to be selected and tested out, both by psychological and by physiological procedures.

If further research substantiates the psycho-neural colour-emotional connections which preliminary results suggest, the practical importance of the phenomenon would be far-reaching. In the education of children, emotional conditioning might be enormously facilitated by use of colours which tended to check undesirable responses and evoke constructive emotions. In the many fields of industry, colours of tools, work-shops, and illumination might be controlled in such a way as to stimulate efficient emotional attitudes toward different tasks, in a manner which no worker could consciously combat. And in the arts, especially theatres and motion pictures, not only might the acquired colour associations, or "natural" colours of various objects be used to set off appropriate emotional reactions, but the whole emotional tone of a scene, play, or character might be predetermined by the colours used in its presentation.

Effective use of colour is now made, very frequently, by expert theatrical producers; though without any basis other than personal experience and native emotional sensitivity to colour. Large motion picture theatres, such as the two or three newest in New York City, make lavish use of coloured lights at nearly all times during the performance. I have been unable to discover any particular system or plan in the selection or timing of colours; but even this promiscuous and often astounding use of coloured light produces a very obvious increase in the pleasure and emotional responsiveness of an extremely heterogeneous and cosmopolitan audience.

In this respect, of course, the black-and-white motion picture has not yet begun to realize its emotional possibilities. If the film action is obvious and melodramatic, the plot may arouse sufficient excitement to obscure the complete flattening out of esthetic background tone, and the tremendous loss in emotional stimulation due to elimination of such stirring colour stimuli as the red lips of the heroine, the sparkling blue of sea or lake, and the flower-like hues of women's costumes at a pictured ball or dance. The producers probably do not realize all the emotional ammunition they are throwing away, or something would be done to put natural colours on the screen.

Moreover, if the indicated psycho-neural associations between primary colours and primary emotions can be substantiated, the emotional effects upon an audience might practically be dictated, throughout an entire film, merely by emphasizing the appropriate colours in each portion of the play. When motion pictures reach such a colour development, they will possess an esthetic value enabling them to portray realistic, homely emotions that now have to be left off the screen altogether because they fall quite flat when portrayed in black-and-white. Also, the emotions of greater masses of people might be reached and improved through this medium than possibly could be touched through any other. Integrative formulation of both emotions and colour sensations seems practically advisable as well as psychologically worth-while.

REFERENCES.

[1] Woodworth, R. S., *Psychology*, 1925, p. 216 ff.

[2] Herrick, C. J., *Neurological Foundations of Animal Behaviour*, 1924, p. 23.

[3] Marston, W. M., The Psychonic Theory of Consciousness, *Jour. Abnormal and Social Psych.*, 1926, Vol. XXI, pp. 161-169.

[4] Adrian, E. D. and Forbes, Alexander, The All-or-Nothing Response of Sensory Nerve Fibres, *Jour. of Physiol.*, 1922, Vol. LVI, pp. 301-330.

[5] Sherrington, C. S., *The Integrative Action of the Nervous System*, 1920, p. 14.

[6] Forbes, A., Basis of Reflex Coordination, *Science*, 1926, issue of August 13, p. 165.

[7] Forbes, A., Electrical Studies in Mammalian Reflexes, II, 1925, *American Jour. of Physiol.*, Vol. XXXIX, pp. 172-235.

[8] Sherrington, C. S., *Ibid.*, at p. 334.

[9] Marston, W. M., Motor Consciousness as a Basis for Emotion, *Jour. Ab. and Social Psychol.*, July, 1927.

[10] Marston, W. M., Consciousness, Motation, and Emotion, *Psyche*, July, 1927, pp. 40-52.

[11] Troland, L. T., Quotation from Letter, 1927.

[12] Ladd-Franklin, Christine, Quoted opinion from letter, 1927.

[13] Herrick, C. J., *Introduction to Neurology*, p. 228 ff.

[14] Sherrington, C. S., *Ibid.*, p. 203 ff.

[15] Watson, J. B., *Behaviorism*, 1925, p. 120 ff.

[16] Marston, W. M., Primary Emotions, *Psychological Review* (in press).

[17] For studies of these " emotional reversals ", see Volume on *The Primary Emotions*, to be published during 1928.

[18] Sherrington, C. S., *Ibid.*, p. 120 and p. 206 ff.

[19] Forbes, A., The Interpretation of Spinal Reflexes in Terms of Present Knowledge of Nerve Conduction, *Physiol. Review*, 1922, Vol. II, pp. 361-414.

READING, WRITING AND GUESSING

By ROBERT SAUDEK

Since the reading of character from handwriting ceased to be merely an ingenious and trivial " art ", an art which could be practised only by those who were born with peculiar gifts : since I. H. Michon, some 70 or 80 years ago, invented the term graphology and wrote a few text-books on the subject, and since we got rid of the so-called " interpretation of signs "—a doctrine according to which certain characteristics of the writer were supposed to be connected with certain formations of letters—graphology has passed through various clearly-defined stages.

At first, it was stated that the handwriting resulted from the graphic fixation of human gestures. The question whether this theory applied only to races who employ an alphabetical script, or whether it referred also to those employing only wordsigns was at that time completely ignored.

We shall see that this theory, which twenty-five years ago was opposed by the Frenchman, Crepieux-Jamin (the Crepieux-Jamin of our days is of quite a different opinion), is just as correct and just as erroneous as most of the theories which are advanced in the first phase of the development of any scientific discipline. As a matter of fact, it affects only a small part of the field of research, and is therefore valid only within those limits.

In the present state of our science we can point to no less than 15 causes which may influence the individual handwriting, and *one* of these 15 causes is precisely this unconscious recording of individual gestures, which we fix upon the paper as we write.

Then followed the important discovery of Ludwig Klages, who distinguished between psychically free (*geloeste*) and psychically constrained handwritings (*gebundene Schrift*). Here again we have only one of the 15 causes, but it is, none the less, one of the most important, and one which seems destined to approximate graphology to the field of research of modern psycho-analysis.

Other interesting discoveries followed. It was pointed out that writing is the only " graphic art " which is practised by the ordinary man, so that he forms his letters with the same uncon-

scious freedom and certainty as are displayed by the born artist in the shaping of other art-forms. Consequently handwriting, according to this theory, offers us a standard by which we can judge how far the ordinary man is sensitive to spatial proportion, beauty of form and rhythmical unity.[1]

From this discovery to the next was only a short step. Since the "ordinariness" of the "ordinary man" consists essentially in the fact that he represents an average type and is almost devoid of any originality, so the aesthetic variations of his handwriting—that is, the individual departures from his school copy-book—are not so much the reflection of his gift for the "graphic arts" as the revelation of his instinct for imitation. Intellectually he draws his sustenance from models which he emulates because they really impress him, or because their superiority has been suggested to him by his teachers or his environment. How far he succeeds in imitating the models of alien handwriting which have been imposed upon him (or have impressed him) depends, of course, on his memory for form, his manual dexterity, his power of concentration, and his aesthetic ambitions. (I shall say nothing here of his writing materials—pen, ink and paper).

Each of these four conditions opened up a special province of research. A series of fresh problems was disclosed.

What elements of an alien handwriting is it *possible* for us to imitate? Which elements do we perceive, and which do we overlook?

This question can of course be answered only on a broad experimental basis. Is it possible for us permanently to incorporate alien elements in our handwriting?[2]

Experiments led to the discovery of the law that in writing for any length of time the attention fails in proportion to the speed of writing. The longer and the quicker we write, the less capable are we of concentrating on the form of our writing, and the more completely do we relapse into our own original manner of writing.

The problem of *memory for form* and its influence on individual handwriting has scarcely been considered in Germany. The way to this problem was prepared by the erroneous theory of the "personal model-image" (*persoenliches Leitbild*) a doctrine of Ludwig Klages, according to which everyone has an innate relation to spatial orientation, which has a decisive influence on the structure and form of his handwriting. But in America, which in this connection

[1] See also the remarks of Mr. Roger Fry in "English Handwritings", S. P. E. Tract No. XXIII, edited by Robert Bridges.

[2] Albert S. Osborn, (New York), Frank N. Freeman (Chicago), the German psychiatrist Dr. Georg Meyer, and the head of the Berlin detective department. Dr. Hans Schneibert, have made permanent contributions to the solution of these two problems.

seems indeed to be a country of limitless possibilities, experiments were made which show how strong is our innate memory of form and how this natural gift is artificially stunted and (one might almost say) in proportion to the degree of our "education"—that is, in proportion to the wealth of impressions that impinge upon us —weakened and uprooted. The experiement could scarcely be made in other countries, for it requires a large number of persons, such as in England, fortunately, are no longer to be found. A large group of children of 8 to 10 years, who were absolutely illiterate, and had received no instruction whatever, whether at home or in school, and were proved to be incapable of reading a single letter, were gathered together from outlying farms and were given the task of copying a whole page of printed type, in freehand, with pencil and paper. The experiment was brilliantly successful; all the copies were plainly legible, although they were made by children who could not read a single one of the letters they were copying. No selection was made of children who had some gift for drawing; but those were selected who were known to have seen printed letters, but had never had the meaning and the sound of the individual letters explained by those about them. They were simply shapes which they had seen but had not understood, and which had remained fixed in their memory, so that their remembered images facilitated the act of copying them.

The degree of visual impressibility is yet another of the above-mentioned 15 causes which affect the individual handwriting, while the writer's capacity for expression determines which of the numerous alien formations that he consciously, half consciously or unconsciously harbours in his memory will be adopted by him, and the manner in which he will vary the different possible formations of the same letters.

Quite recently the theory was advanced in Vienna that men who are possessed by fixed ideas or manias form their letters in such a way that these may almost be regarded as illustrations of those manias. I am not speaking of the absurdities of those "seers" who detect the trigger-guard of a revolver in a certain shape of the letter D and conclude that the writer intends to shoot himself, or see the outlines of aeroplanes in the signatures of aviators[1], but of the assertion of certain psychiatrists, who in special formations of letters are given to detecting manifest sexual symbols.

In itself the observation is correct. Such obsessions are frequently reflected in the formations of letters, but we must not immediately point to a particular form of the letter *b*—the *beta*-form (β) as the

[1] For some little time the newspapers were full of reports of performances of this kind on the part of a Viennese "psychographer", Rafael Schaermann.

" well-known sexual symbol ". As we shall see, we shall be justified in deducing such an obsession only when quite different letters repeatedly show a resemblance to sexual objects; but hardly when this peculiarity relates to one single letter.

Hitherto a very large number of problems have been made inaccessible to graphological research by two circumstances in particular.

In the very early days of scientific graphology the graphologists were justly reproached with drawing their conclusions not only from the characters of the handwriting, but also from the content of the script.

In order to counter this reproach, the German text-books admonished the student to pay no attention whatever to the content of the script; to *see* it only, not to *read* it. This nonsensical rule has to this day never been explicitly disavowed.

In France, again, the doctrine of " graphically fixed gestures " prevails to this day. And the logical consequence of such a doctrine was that the graphologists were expected to concern themselves with the gestures, and not with the content of the text. Moreover, the leading graphologists of both countries did not happen to be particularly gifted as linguists, so that they based their theories exclusively on handwriting in their own language, and hardly ever employed a foreign script as material for research. Lastly, it so happened that the graphologists carelessly overlooked the results of the conclusive mass-experiment which was provided by the practice of the new modern method of writing in thousands of schools all over the world.

Under these circumstances what was left of certain of the graphological dogmas of the old school? What, for example, of the assertion that vertical writing denotes reserve and composure, and a sloping hand a capacity for self-sacrifice and adaptability, when a hundred thousand of the rising generation write an upright hand for no other reason than that they were taught the modern vertical handwriting at school, instead of the old sloping handwriting? What of the doctrine that heavy pressure denotes energy, when at least 20 million Americans write without pressure, or with very little pressure, because it has been shown in the American laboratories, by repeated measurements, that a script written without pressure is more quickly produced—in other words, is " more efficient " —and because this method of writing is to-day taught in all the American schools? What of the doctrine that a careless hand with negligently and imperfectly formed letters denotes either haste or superficiality, when it has been proved that there are four different kinds and four different causes of such careless writing?

In order to understand this last conception we must consider the question of the essential nature of the connection between the *writing* and the *reading* of the thing written.

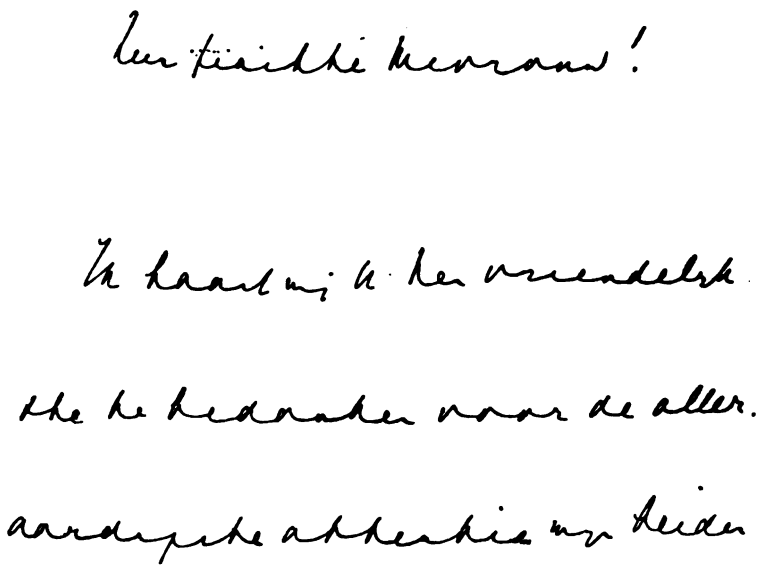
We write either in order to record our thoughts for ourselves or in order to communicate them to others. If during the act of writing we give any thought at all to the reader, we shall write most plainly to those persons to whom our handwriting is as yet quite unknown; if we can presume that the reader is acquainted with our hand we let ourselves go a little, and we pay the least attention to our caligraphy when we are making notes for our own use. But even in the two cases where we are writing for other people our self-restraint will last only over the beginning, or the half, or three-quarters of the manuscript; but never to the end. Here we see in operation the law of failing attention in proportion to the duration and speed of the act of writing. (But this last is a concomitant phenomenon which we need not consider at the moment.)

What concerns us at present is the differing legibility of the script in cases 1, 2 and 3. We may not produce a beautiful copper-plate hand in any of the three cases, but the greatest deviations from the school-copy will at all events be found in the notes hastily written for our own use. And in all three degrees of deviation the decisive factor is the hypothesis that anyone can as a matter of course read handwriting which deviates from the form of writing on which society has agreed for purposes of mutual understanding, and which is taught in the schools as the standard means of written communication.

This hypothesis really means just this: that we believe that anyone can *guess* the meaning of written characters that retain scarcely any resemblance to the conventional forms. Although we might really call it a presumption rather than a hypothesis, it will in most cases prove to be justified, if the reader is of the same nationality as the writer, or if, although a foreigner, he can himself *write* the language in question.

But the reading of a fully developed handwriting is always a matter of guesswork. As long as we are reading only manuscripts written in our own mother-tongue we do not become conscious of this fact; but the moment we have to read a foreign language which we think we have mastered we are at once made aware of it, and directly we have to spell out a manuscript in an unknown language we encounter insuperable difficulties. At the very best we may recognize 70% of the letters; but in most cases a smaller proportion. I am accustomed to lecture on graphology in five different languages, and in experiments of this sort I have never obtained a better result than 70%.

The specimen of Dutch handwriting (No. 1) affords an excellent illustration. Any Dutchman could read it as though it were copperplate (that is, as though the conventional formation of the letters were strictly maintained). Every reader who has any notion of the Dutch language will naturally read the third word as *Mevrouw*. All others will probably read it as *Miorouu*. No one could read the preceding word as *geachte*, for only the letters *a* and *e* —that is, two out of seven—are conventional in form ; but anyone who has ever seen a letter written in Dutch can *guess* the word from the context. (Geachte Mevrouw = Dear Madam). No one could *read* that the first two words in the third line are not *aardipite abbenbie* but *aardigste attentie* ; but any Dutch reader will guess as much.



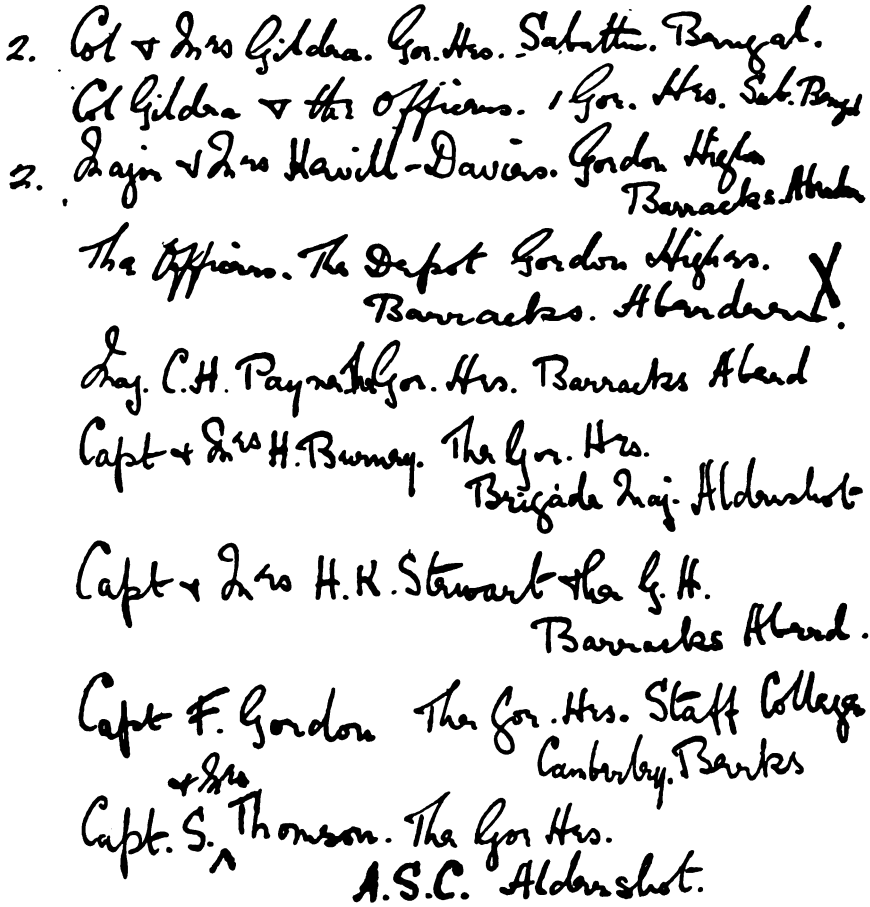
No. 1

If a German who can only just speak English writes a letter in that language he will form his letters very distinctly ; very much as a deaf man, in order to make himself more intelligible, will shout at a person whose hearing is perfect ; that is, he will " project " his own disability upon the other.[1]

If now we write in our native language, quickly and carelessly, neglecting the matter of legibility, with blotted and blurred characters, the question that arises is whether the whole text is negligently written, or only a few words. A thoroughly careless hand-

[1] A number of other aspects of this problem of national handwriting will be found on pp. 98-115 and 197-213 of my *Psychology of Handwriting* (with 120 facsimiles of handwriting), Allen & Unwin, London; Doran, New York.

writing reflects the general carelessness of the reader. If the writing is negligent and rapid, it shows a strong inner impulse or a hasty, temperamental, superficial character; if it is negligent and slowly written it indicates extreme laziness.


2. Col & Mrs Gildea. Gor. Hrs. Sabathia. Bengal.
Col Gildea & the Officers. Gor. Hrs. Sab. Bengal
2. Major & Mrs Havill-Davies. Gordon Highrs
Barracks. Aldershot
The Officers. The Depot Gordon Highrs.
Barracks. Aldershot.
Maj. C.H. Payne R.A. Gor. Hrs. Barracks Aldsd
Capt & Mrs H. Burney. The Gor. Hrs.
Brigade Maj. Aldershot
Capt & Mrs H.K. Stewart The G. H.
Barracks Aldsd.
Capt F. Gordon The Gor. Hrs. Staff College
Canterbury. Barracks
Capt. S. Thomson. The Gor Hrs.
A.S.C. Aldershot.

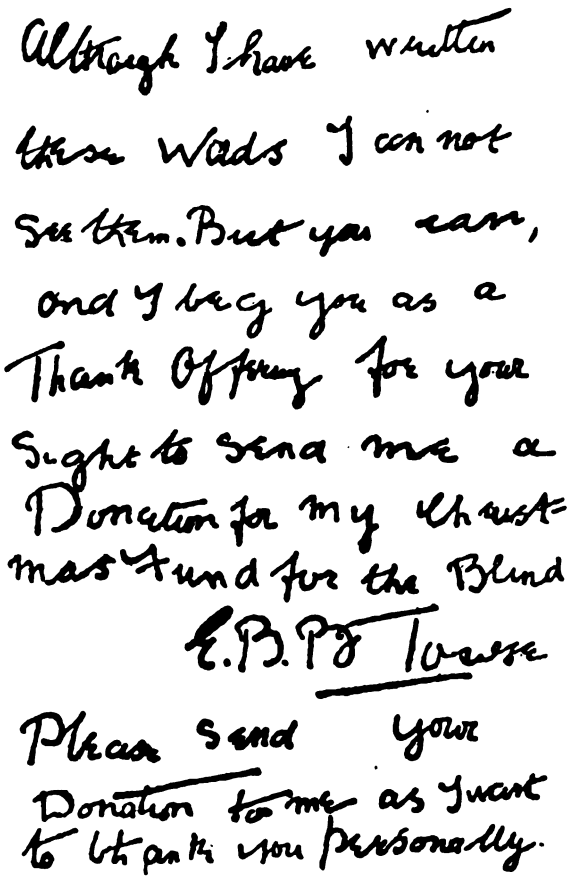
No. 2

The most frequent cause of careless writing is rapidity of *tempo*; and in Germany the censorship of the eyes is held to be the principal check on such carelessness. This latter assumption, however, is only partially true.

Very numerous and thorough experiments with persons who were required to write either in darkness or with bandaged eyes have proved that only the spacing and not the form of the letters is influenced by the censorship of our eyes. It might be objected that in such experiments the writer's memory of form is so vivid that it cannot so far degenerate as to become inoperative at the

very first attempt to write without the censorship of the eyes. For this reason I chose my example from the great group of writers who were permanently blinded in the war.

Specimen 2 shows the handwriting of Captain (Sir) E. B. B. Towse, V.C., 20 years ago; Specimen 2a the present handwriting of the President of the National Institute for the Blind. Although


Although I have written
these words I cannot
see them. But you can,
and I beg you as a
Thank Offering for your
Sight to send me a
Donation for my Christ-
mas Fund for the Blind
E.B.B.P. Towse
Please send your
Donation to me as I want
to thank you personally.

No. 2a

there is an interval of 20 years between the two, and although the writer was completely blinded some years ago, the two handwritings reveal very few points of difference.

As a matter of fact, the check which restrains us from writing either a completely or a partly negligent hand is predominantly psychological.

We think more rapidly than we are able to write, and in writing individual sentences our writing lags behind our thought. Al-

though, as a matter of fact, we are never in a position to bring the rhythm of writing and the rhythm of thought into unison, we try to arrive at a compromise ; by neglecting the proper formation of individual letters we facilitate the act of writing and hasten its tempo. We do this most completely in notes written for our own use. The inward impulse which compels us to write quickly leads us to overestimate our subsequent ability to guess at the meaning of our notes, and it is only when we come to read them, and find ourselves unable to decipher our own handwriting, that we first become conscious that our optimism was unjustified.

In letters written to intimate acquaintances although they are familiar with our handwriting, we do not write quite so hastily. The attrition of such word-endings as *-ion*, *-fully*, is of no great significance ; anyone can easily guess at them without being conscious that he is guessing and not reading. They betray merely a careless haste on the part of the writer ; nothing more. If, however, essential parts of the text are mangled and " worn away ", this fact has a much deeper and symptomatic significance.

That is to say, if all the signs of haste and carelessness point in the same direction, if those words which are equally " worn away " stand in such an inward relation that they conceal the same complex of thoughts and images, then this " liberation " is of a psychopathic nature and points to the mental complex which the intellectual (not the visual) censorship of the writer is endeavouring to brush away, to juggle out of sight—or, as we say, is unwilling to admit.

In just the same way in cases of extreme restriction (*Bindung*) occurring in certain places—that is, in all those places where the pen can no longer struggle against a physical inhibition ; where it stumbles, so to speak, on the paper—if the sense of the words thus inhibited points in the same direction, and refers to the same thought-complex, this inhibition shows that the psychic censor (the " bad conscience ") is here endeavouring by a contrary method to disguise the same facts.

CONSCIOUSNESS, CHRONAXY AND NERVE FIBRE RADIATION

By OLIVER L. REISER

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I The Embattled Psychologies

The statement that the problem of psychology is to explain human experience and behaviour looks innocent enough. But differences immediately arise when we attempt to state what we mean by "explanation." Some psychologists would argue that explanation is merely description. Behaviorists would deny that they have any concern with "experience." Gestalt psychologists would insist that we must not only describe what human beings do and experience, but also give a genetic account of how human beings came to be what they are. All this leads us to conclude that psychologists differ concerning the following points: (1) as to the subject matter of their science; (2) as to the method of investigating that subject matter; and (3) as to the method of explaining the content of that subject matter. In such chaos there is room for each of us to have his say.

In this paper I shall assume that the following facts are the principal types of psychological content to be explained. There are (*a*) such forms of behaviour as reflexes, instincts, and habits. These are usually called behaviour patterns; they involve observable responses. There is also a form of response (*b*) called reasoning or thinking. This intelligent behaviour must be contrasted with mechanized response. Finally, there is (*c*) that type of response usually treated under the term "perception," which is a study of the qualitative character of experience as it comes to us through our various senses.

Now among all the various schools of psychology the main point of difference lies between the behaviorists, who completely exclude any content which is not accessible to objective study, and the other schools, admitting into their science the subjective content which can only be studied by introspection. By arbitrarily limiting their own field of investigation the behaviorists have been able

to avoid a certain defect which attaches to most other psychological doctrines. They have recognized the unitary character of the organism. This has lead to a reduction in the number of categories and introduced a simplicity into their explanations which is lacking in other types of theory. Thus, to illustrate, memory and habit, in behaviorism, are treated as special cases of the conditioned reflex, whereas in most psychologies there is little organic unity between the different levels of the previously mentioned types of response. Each subject, like perception, conception, imagination, memory, etc., is treated separately—as though (for example) the explanation of sensation threw little light upon the nature of conception, memory, etc. To a certain extent this method of treatment is simply a heritage of faculty psychology. But it is also due to the present inadequate nature of conceptions of the physiological conditions underlying conscious processes. This piecemeal method of explanation is undesirable. If psychology teaches us anything it teaches us that the organism is a unity; that perception is not entirely distinct from conception; and so on. This partitioning off of the mind into water tight compartments is already disappearing in some types of psychological explanation.

Let us keep in mind that whatever explanation we offer for any aspect of human conduct, it must be of such a character that it can be integrated into our notions derived from a study of other aspects of organic life. Fortunately, it now seems possible to achieve a measure of unity in our explanatory concepts. Still more significant, it also seems that advances in physiology and biochemistry enable us to break down some of the barriers between different types of psychological explanation. I shall attempt to state a view, based on the results of investigators of varying kinds of convictions, which promises something by way of synthesis. I shall introduce my statement with a discussion of that bone of contention, the problem of perceived qualities.

II The Status of Qualities in Modern Thought

If we could personify quality we might call it the Wandering Jew of philosophy—homeless and with no place to lay its head. The way in which quality has come to this tragic pass is as follows: The physicist, concentrating on the more permanent aspects of the external world, has eliminated colour, odours, sounds, tastes, and temperatures from his world of ultimate elements. Positive and negative particles of electricity have only the *primary qualities* of shape and mass. The physicist's world is an abstract world of quantities, stripped of all the richness that we ordinary mortals

think we perceive in Nature. Therefore, in what some would now call traditional psychology, room was made for the sensed qualities, which the physicist expunged from his world, in the concept of *sensations*, conceived as elements of conscious states. This took mind, with its *secondary qualities*, out of the world of physical nature. Now, as we have seen, behavioristic psychology, wishing to " naturalize " man, has had to reject the notion of mind as constituted of elements with qualitative attributes, and substitute sensori-motor discriminations of various wave lengths of light for the various "colours," and analogous explanations for other experiences. At the same time the behaviorists have refused to enrich the environment with the cast off garments of conscious content. But however you may explain (or explain away) colour, all must admit that such terms refer to some sort of differential activities which go on in organisms when they perceive and react to qualities.

We speak of objects as being red or green, bright or dull, cold or hot, sweet or sour, and so on. Where are these qualities which, to appear, seem to require both an organism and an environment? Is the red of the rose an attribute of the rose? The answer to this is not as obvious as it may seem. The unsophisticated person (the " naive realist ") believes that the red is really in the rose. But the physicist asserts that the colour depends on the light reflected from the rose, and that this reflected light we call red. This would indicate that the rose is (or has) all colours *except* red. But the physiologist knows that when the rose which appears red when looked at directly may appear yellow or gray when the image falls upon the peripheral part of the retina. He is therefore inclined to regard colour as an attribute of the eye. Finally, to the psychologist who believes in consciousness, the red is neither an attribute of the rose, nor the light, nor the eye, but a definite qualitative entity in consciousness.[1]

Now if the physical monists in psychology insist upon pushing qualities out of the experiencing organism, and the physicist will not tolerate them in his universe, where in the world are qualites? Or are qualities like the fictitious creatures of mythology—only imaginary entities: kept alive, perhaps, by philosophers to have something to dispute about?

III The History of the Problem of Qualities

The world is presented to consciousness in the form of qualitatively different kinds of sense experience. But in the midst

[1] Adapted from J. H. Parson's *Introduction to the Study of Colour Vision*, 1915, p. 22.

of the panorama of qualitative changes there are foci of permanence. To explain this fact of permanent realities enduring through change it has been the natural tendency of the mind to postulate some underlying substratum as the seat of qualitative changes. One of the earliest problems of Greek philosophy was to describe the nature of this original essence or stuff. From the time of Democritus, who first assigned to secondary qualities a subjective status, primary qualities have been taken to refer to those properties of objects (or "matter") which the physicist can isolate. In the early period of modern thought this doctrine of the subjectivity of secondary qualities was revived by Galileo, and is embodied in the views of Descartes, Hobbes, and others. In speaking of light Newton states: "The rays, to speak properly, are not coloured. In them is nothing else than a certain power or disposition to stir up a sensation of this or that colour. . . . ." The effect of John Locke's view was to reinforce this distinction. Berkeley alone, at that time, held that secondary qualities are in the same boat with the primary qualities.

Modern psychology refused to follow Berkeley. Physics likewise reaffirmed the dualism of primary and secondary qualities. The notion of sensations as elements of consciousness, having certain attributes such as quality, clearness, intensity and duration, and as bearing a certain relation to the magnitude of the stimulus, was definitely formulated by E. H. Weber. Weber's law states that there is a constant ratio between the scale of sensible intensities (sensations) and the increase of intensity of the physical stimuli. Fechner continued the work of Weber and, by assuming that the "just noticeable differences" in the scale of sensible intensities were equal, Fechner was able to give Weber's law the well known methamatical form, the sensation varies as the logarithm of the stimulus. This law is analogous to the law of diminishing utility in economics.

The notion that the qualities of sensation are the subjective correlates of the magnitudes of the primary physical system was more firmly established when incorporated in Johannes Muller's doctrine of the "specific energies of the nervous system." This doctrine states that the quality which characterizes any mode of sensation is dependent upon a specific *quale* of nervous energy, and not upon the method of stimulation. For example, mechanical stimulation of a sense organ (as the eye) may yield the same (visual) sensation as will chemical or electrical stimulation of the same receptor. Wundt gave psychophysics and the doctrine of sensations an added impetus.

It is now clear that most of the problems of modern psychology

grow out of this disjunction between mind and matter which the distinction between primary and secondary qualities created. It is also evident that if Galileo, Newton, and others at the beginning of modern science, had stated their philosophies of nature in different terms, the present formulation of psychological problems would have been different. To solve these problems does it not follow that while we must take into account the very real qualitative characteristics which traditional psychology put into the mind, we must also overcome the dualism which is so unacceptable to the monists? Granted that such a solution is desirable, it is also feasible? and how is it to be accomplished?

It seems to me that it can only be accomplished by widening our conception of physical reality. To overcome the dualism of mind and matter we must retrace the course of physics and get the secondary qualities back into the material world. (To those familiar with Dr. Whitehead's ideas there is nothing radical about this proposal.) However, before suggesting my own hypothesis it is well to state and criticize the behavioristic solution.

IV Another Refutation of Behaviorism

The behaviorist, since he considers the human organism to be nothing but a physico-chemical machine, denies the existence of anything different from observable physical processes. Very well. Let us take a simple example which can be demonstrated in a class room. Professor R. S. Lillie (for whom the behaviorists have great respect) has devised an excellent analogy for exhibiting what goes on in nerve conduction. Let an iron wire be wrapped around a glass rod and the whole thing be immersed into a jar containing a weak solution of nitric acid. When the wire is touched with a piece of iron a wave of chemical activity can be observed to travel along the wire. After being "excited" a period of inactivity must follow; then restimulation is possible. This corresponds to the refractory period of the nerve. Other phenomena of nerve conduction can be duplicated by this "iron nerve." Let us further assume that the exposed end of the iron nerve corresponds to the exposed nerve of a tooth. The behaviorist is then faced by the following dilemma. He must either (*a*) admit that the iron nerve, like an exposed nerve in a tooth, actually suffers pain—in which case he is an "anthropomorphist," and no longer a good behaviorist; or (*b*) he must deny that human beings suffer from tooth aches in such situations—in which case he is denying fact, and therefore no longer a good psychologist; or (*c*) he must admit that the analogy breaks down as an adequate picture of the facts. This is equivalent to saying that something goes on in neural

processes in an individual which is not observed to go on in the transformations involving only primary qualities in the iron nerve. This will hold for *any* picture of nerve conduction, so long as only primary qualities are admitted into our physico-chemical pictures. So far as the behaviorist is concerned the mere increase in quantitative complexity in nerve tissue, and the addition of some laryngeal muscles to shout "ouch"! when the dentist touches the nerve, can add nothing to the essential situation. Since this argument can be applied to nerve conduction in any field of sensory experience, it throws out the whole of radical behaviorism insofar as it rests upon the statement that in human beings only phenomena involving primary qualities can occur. Now, personally, I am willing to admit that the iron nerve has something analogous to sentience, but since the evidence is clear that consciousness is correlated with cortical synaptical activity, I shall suppose that some sort of integration and intensification is necessary to produce that particular type of unitary experience which human beings recognize as consciousness.

V Nerve Conduction and Qualities

In discussing the relation of consciousness to nerve conduction the following problem arises. To what extent is the process of conduction the same in all the nerves? Is nerve transmission in vision the same as in audition? If so, how are the qualitative differences arising in the different sense organs transmitted? If not, how must the Nernst-Lillie picture be modified to take care of the qualitative variables? In replying to this question it is convenient to return to the doctrine of the specific energies of the nervous system.

This doctrine does not occupy the important position which it formerly held. The reasons for this are well stated by E. B. Holt in his article in the *New Realism* (pp. 303-373). The idea of nerve energies qualitatively different for each of the senses must be rejected because, among other things, nerve physiology has been unable to discover suitable chemical or histological differences among cortical cells and synapses. In addition to the reasons which Holt cites, there is the fact that *the same bipolar neurone may transmit different sensations*. This puts an end to the specific energies theory.

In Holt's article the suggestion is presented that recent discoveries in the fluctuation, sometimes of high frequency, in the sensory nerve may provide a satisfactory substitute for the specific energies doctrine. Holt would substitute the *neural periodicities* or *physiological densities* theory for the older view. He also believes

that this will dispose of the doctrine of *gestaltsqualitäten*, which was proposed by Ehrenfels to explain the psychic unities or unique qualitative wholes of experience. (I do not know whether Holt now believes that his interpretation also weighs against the present doctrine of *Gestalt* psychology.)

A view somewhat along the same lines has also been presented by Professor L. T. Troland.[1] The first suggestions were as follows: The " all or none " phenomenon has been shown to hold for individual nerve fibres as well as muscle cells. Add to this fact that when a cell responds it reacts to its maximum the additional fact of the refractory period (.002 of a second), and it is obvious that the number of impulses which can traverse a single nerve fibre is limited. The problem is then to show how gradations of quality (red, green, etc.) as well as quantity (or intensity) can be tranmitted by the same nerve elements. Some experiments seem to show that we must reject the notion that the intensity of visual sensation depends on the number of fibres stimulated. Now if we correlate the intensity of visual sensations with the frequency of the nerve impulse (i.e., the total number of quantal pulses passing through any fibre per unit interval of time), then the qualitative aspect must depend on something else. Troland's suggestion is that the qualitative aspects may be represented by some sort of " group frequency."

This suggestion is expanded by Professor Troland in his very excellent book *The Mystery of Mind* (Ch. XIII). In amplifying the idea Troland ventures the suggestion that the pulse frequency is responsible for the cortical process underlying *brilliance* of colour. The particular *hue* which is exhibited may depend upon the exact *form of modulation* (employing an anology from radiotelephony) which is impressed upon the nerve current. Troland supposes that the cortical neurones are able to differentiate the various aspects of visual experience because this set of elements (of the visual cortex) is somewhat like a radio receiver " tuned " to particular wave lengths. There are nerve arrangements tuned to " red ", and the " red receiver " will pick out that special rhythm which represents red in the nerve current. " The ' red excitation ' in the cortex, regarded as a whole, is a combination of structural and dynamical features. *It is a certain structure undergoing a certain change.*"

The conscious factors, such as red, are apparently simple, while the corresponding physical factors are quite complex. As an explanation of this Troland suggests that the physicist probably

[1] " The ' All or None ' Law in Visual Response ", *Journal of the Optical Society of America*, Vol. IV, No. 3, pp. 160-186.

overemphasizes the structural aspect of the thing he studies. Troland believes that there are special electrical-field structures underlying conscious qualities. The electrical fields of force may be regarded as unitary things (responsible even for the " form-quality "), which the physicist tends to disregard.

The only criticism of Troland's view which occurs to me is that the hypothesis of specific " receivers " seems to assume the doctrine of stabilized localization of function, and K. S. Lashley has shown that the centre of vision may shift around in the visual cortex.

VI Chronaxy and Nerve Fibre Radiation

In the foregoing discussion the fact must have stood out clearly *that the notion of rhythms or frequencies of neuronic discharge (i.e., time-interval periodicities) is the only adequate substitute for the doctrine of the specific energies of the nervous system.* Those who are familiar with Professor Lapicque's ideas in this field will recognize a similarity between his ideas and those above presented. For the readers of *Psyche,* who are no doubt familiar with C. K. Ogden's lucid expositions of " Chronaxy," no extended presentation is necessary. However, one fact may be emphasized, which is stated by H. Pieron in his *Thought and the Brain* (p. 143) as follows: " In every case, from the fact that a chain of neurones is set in operation, with all its reaction processes, which depend on its connections and chronaxic coefficients, there is a sensory specificity connected with the individuality of responses. This represents the form that Muller's important principle of the specific energy of the nerves may take to-day."

Now I would like to present the most satisfactory detailed picture of the intimate nature of neuronic tuning with which I am familiar. This should be all the more welcome because English investigators are not so likely to be familiar with the recent paper of Dr. H. M. Johnson[1]. Dr. Johnson's explanation has all the merits which we previously observed to attach to the behavioristic method of approach. In addition, his interpretation of synchronism provides a substitute for the specific energies theory—something which no previous behavioristic system promised.

The problem of learning is that of explaining how conductivities in the direction of particular effectors are modified and stabilized, Dr. Johnson tells us. To accomplish this in full a picture of the microscopic mechanisms underlying " conductivity," " resistance," " inhibition," " facilitation," etc., is required. No other type

[1] " A Simpler Principle of Explanation of Imaginative and Ideational Behaviour and of Learning ", *Journal of Comparative Psychology,* Vol. VII, 1927, pp. 187-234.

of hypothesis fits the facts of the *specificity* and *variability* of conduction as well as the concept of chronism. In Johnson's view the explanation of chronism lies in the relation between the discharging-frequency of the afferent cell and the charging frequency of the efferent one.

The mechanism which is suggested consists in visualizing the neurone as a conductor with a permanent membrane acting as a sieve, permitting the transfer (virtual or real) of the charged particles. Bayliss' notion of a limiting membrane is rejected, because the Langmuir layer, assumed by Bayliss, will not perform the function which Lapicque describes. The *surface-membrane* has a *surface-film*, which is simply a Helmholz double-electric layer. The surface-membrane is selectively permeable to the layer of ionized molecules *absorbed* to the surface membrane. When the field of force is constant the elements of the membrane assume a definite orientation, and a reversal of orientation, produced by an alteration of the electromotive force, is necesary to render the film permeable to an iron to which it was previously impermeable. Dr. Johnson assumes that the time required for reversal of orientation of the molecules of the surface-film is specific for a given cell, and that the reciprocal of the orientation-time represents the number of oscillations of the surface charge. This film frequency, F, bears a mathematical relation to the discharge frequency, *f*, of the cell.

The all or none law, in this view, takes its origin (in part) in the fact that a second process of " irritation " must await the preparation of a fresh supply of material, including the proper orientation of the molecules. Whether conduction will occur from one cell to another depends upon whether the two cells are " tuned ", which depends upon whether a cell is in its " refractory " period. The film of the cell is conceived to possess a mechanism analogous to the grid of a thermionic tube, acting as a tuner. Learning thus is the forcing of oscillation-periods of neurones into efficient relation with each other.

In this beautifully simple scheme all the problems of learning, thinking, attention, inhibition, reinforcement, and of transfer of function reduce to a simple mathematical problem of finding the highest common factor in the film frequencies of the afferent and efferent cells concerned, and dividing by the film-frequency of the afferent cell ! Thus, if the conductivity of synapse AB is six times as great as that of synapse AC, A will discharge into cell B six times as often as into Cell C.

As stated in the earlier pages, I am assuming that the problem of psychology is to explain the three principal types of experience

and behaviour there set forth. So far as I can see, Doctor Johnson's scheme explains satisfactorily such responses as are characterized in our first two classes of activities. However, in spite of the fact that he provides a basis for specificity of nervous function, I doubt whether sufficient provision is made for the qualitative elements of conscious experience. Dr. Johnson's view of this (expressed in personal communication with the writer) is this: "A 'quality' may perhaps be explained when the physical conditions under which it appears, or under which it is reported to appear, are adequately described. By definition the quality is not the physical conditions—e.g. a certain yellow is not a certain vibration frequency or a superposition of a number of vibration frequencies. To identify the quality with the latter, one simply substitutes definitions. What is the use?" In such a view quibbles about the "riddle" of qualities seem to be nothing but disputes concerning definitions.

I am not at all sure but what I can agree to this,—provided we insist that the quality is identical with *all* its physical conditions. Now part of the physical conditions of external physical light are wave motions. (I presume the wave theory of light is still acceptable.) If *all* the physical conditions are present in *perceived* light, wave motions must also be present in the brain. Professor Troland, as we have seen, admits this in his notion concerning the importance of fields of force in cortical processes. Several years ago I also proposed the same idea. In addition to the assumption that the nerve process preserves something corresponding to all the properties of the external wave frequency, the assumption is made that in the brain there is reinstated a typical form of vibratory phenomenon somehow corresponding to the external wave frequency. Now we might argue until doomsday about such matters, but fortunately evidence is forthcoming that some sort of light is present in nerve conduction (at least in visual experience), and this experimental evidence takes precedence over all theoretical considerations.

On another occasion I summarized briefly the results which have lead Dr. Ladd-Franklin to conclude that nerves may shine by their own light, and that it is correct to say that one can really see his own nerve currents. Mrs. Ladd-Franklin asserts that perhaps all nerve fibre, when in a state of activity, emits physical light (or some radiation of higher frequency which immediately becomes light through flourescence). This would seem to turn the human brain into a glow worm, and perhaps justify the statement of a German materialist, "Kein gedanke ohne phosphor!" Interpreted literally this may seem ridiculous, but it occurs to me

that Dr. George Crile argues in his *Bipolar Theory of Living Processes* (p. 66) that the central nervous system is the direct descendant of the nucleus of the original unicellular organisms, and I also seem to recall that one of the principal constituents of the nucleoproteins is phosphorus! However, I don't press the point.

While the problem of animal light has long interested the firefly people (as Mrs. Ladd-Franklin calls them), as a matter of fact the " cold light " of lightning bugs is not likely to throw much illumination on human nerve radiation,—since A. V. Hill has shown that a minute amount of heat is given off by stimulated nerve. Since experimental evidence indicates that this radiation can be detected by appropriate instruments, the presumption is that such explanations as are based on " induced currents " fall to the ground. This evidence has been produced by Nodon, in France. The organic substances studied by him are capable of taking their own photographs when they are of high vitality.

The writer has embroidered on to these facts the hypothesis that introspection is simply neural photography, and that the conscious aspect *is* the force-fields accompanying the electro-chemical reactions in the cortex. However, difficulties arise when we try to extend such an idea to the activities of nerves other than the optic nerve. But perhaps there is a way out of the difficulties.

Let us suppose that each nerve, carrying its own mode of sensation, can transmit the external qualities to which the receptor which innervates the nerve is attuned. (The aerial, and the wires to the loud speaker, of a radio set carry the manifold qualities of an orchestral symphony. Why shouldn't a nerve also?) There is then no reason for supposing that the field of force associated with the auditory sensation should resemble that associated with the transmission of a visual impulse. Now since we regard " chronaxy " as providing the underpinning for the qualitative aspects formerly explained by the specific energies theory, we must suppose that there is some characteristic relation between the frequency of neurone discharge and the associated nerve fibre radiation, which, in the case of vision, manifests itself as visible light. How it would manifest itself in other nerves (e.g. cochlear, splanchnic, etc.) is a matter concerning which I have no information.

The assertion of a connection between nerve radiation and chronaxy rests largely upon a priori grounds, but the following considerations may lend weight to the view. Many investigators recognize that the nerve cell is like an electric battery, possesssing a supply of potential energy which can be released as a " trigger-effect." Now where is this potential energy stored? Professor Troland regards potential energy as represented by the stretched

" lines of force " which make up the fields. If so, must not the constellations of lines of force somehow alter the chronaxies of their respective neurones? (In connection with this problem of the rôle of field-forces and potential energy in consciousness may I suggest that there is excellent opportunity to derive an interesting theory of consciousness by comparing the idea of Troland, the views of the gestalt psychologists, who regard the " closure " of physiological gestalten as an expression of the tendency to reduce the potential energy of the system to a minimum, and the conception of Professor W. P. Montague that consciousness is simply a continuum of potential energy built up by the minute toll which each synapse levies on passing nerve currents?)

One more suggestion and I am through. The various sense deliverances have little in common except that they are vibratory phenomena, i.e., periodic disturbances travelling through space and time. Perhaps visual, auditory, and other nerve impulses are integrated into the unity of consciousness through some sort of harmonic synthesizer. In such a view the physiological aspect would be represented by the basic fundamentals (of the corresponding Fourier's series), and the progressing music of consciousness would correspond to the overtones. Here we would be embracing a theory which Plato (or Socrates) rejected several thousand years ago—that the soul is simply the harmony of the body ! With these wild and cryptic remarks I must leave the matter.

SPINOZA AND EXPERIMENTAL SCIENCE

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I

It would be difficult wholly to forget in reading the correspondence of Spinoza that he lived in the century which saw the birth of modern science. He is concerned frequently in the parts of his letters that have come down to us with the problems of theology and metaphysics, but frequently too his comments turn to the men and the problems of the early movements of science. The fact should in itself be significant. Nevertheless one finds little proper evaluation, when Spinoza is considered, of the peculiarities of the environment of his century. Or if they are insisted on, a mysterious fatality accompanies the insistence: either his indifference to and ignorance of the methods of science are remarked and lamented or he is assigned facilely to a place of a little honour for yoeman service, the minutiae of which are now unfortunately antiquated, among the pioneers of science!

For the most part Spinoza was aware in detail and clearly of the intellectual currents of his age. He followed with interest the beginnings and the progress of science, and what has been taken for indifference and ignorance, is really a definite and clearly thought-out heterodoxy. His view of science permitted him to doubt the accuracy of the interpretation which early scientists and philosophers of science put on experimentation. But the centuries which have followed the seventeenth have taken up its enthusiasm for experiments and have accepted its interpretation of what those experiments accomplished. Philosophers in that tradition have had no difficulty in tracing Spinoza's doubts to misconceptions; and if it were a question only of that, it would be of small matter; one might even acquiesce easily in drawing the nets of crossing influences and say he was an experimentalist since, despite his criticisms, he was of course influenced by Bacon and Descartes. But as there grows from the denial of the name of Cartesian to Spinoza something more than a question of nomenclature, so too what seem minor differences in his interpretation of science are at bottom

important metaphysical distinctions. He had no facile *a priori* disdain for empirical methods. He was too much interested in the problems of method and validity to neglect the claim of any method of knowledge. Certainly he was aware that there were empirical schools in formation, since he promised to examine "the methods of proceeding of the empirics and recent philosophers",[1] and he assigned their method to a low place in the scale of certainty—to the second of the four ways of knowing. He conducted experiments himself, as is evident from his recourse to them in his controversy with Boyle.[2] One of his letters is devoted to the details of the conclusions he has come to by experimentation in a problem which he had already discussed[3] and the problem is concerned with nothing other than research in hydrostatics, relative to the possible alterations in pressure and speed due to variations in the horizontal length of the tube. He was, moreover, an expert in the theory and practice of optics. Hudds and Jellse submit to him their practical difficulties in the calculation of the best lenses, the construction of telescopes, their difficulties with Descartes' *Dioptrics*[4]; Leibnitz sends him his *Notitia Opticae promotae* for criticism[5]; his *Treatise on the Rainbow* is an elaborate mathematical analysis of the phenomena of refraction and reflection; and there is indication that his interest in the problems involved in those phenomena continued lively, since in 1676 he urges Tschirnhaus to send him from Paris whatever has been discovered recently concerning refraction.[6]

There are finally inquiries and remarks scattered all through Spinoza's correspondence on Mechanics and Physics, and on astronomical observations particularly as they may relate to the Cartesian system of physics. Oldenburg and Spinoza are for a long time very much concerned with the possible explanation consistent with the Cartesian *system* of the movement of two newly discovered comets.[7] Spinoza writes to Oldenburg also of conver-

[1] *De Emen. Int.*; II, 13, note 1.

[2] Epistolae VI, XI, XIII, XIV, XXIX; IV, 15-36, 48-52, 63-69, 69-72, 164. Colerus records in his life of Spinoza that he was interested in the habits of insects and made frequent observations with the microscope.

[3] Epistola XLI (olim 46) to Jarig Jelles; IV, 202. "His paucis, quid de eo, quod primo coram, deinde literis a me petiist, experientia deprehenderim narrabo."

[4] Epistolae, XXXVI, XXXIX, and XL; IV, 186-187, 193-195, 199-201.

[5] Epistolae XLV and XLVI; IV, 230-234.

[6] Epistola LXXXIV; IV, 335.

[7] The discussion is opened in Epistola XXIX (1665) (IV, 165) when Oldenburg announces that the astronomer John Helvel of Danzig has written him that his *Cometographia* is on the press and almost ready (it was published in 1668) and that he had sent him his *Prodomus Cometicus*; the latter which contained a detailed description of the recent comets had not yet arrived.

sations with Huygens[1] of discoveries with microscope and telescope and of determining the nature of the rings of Saturn; there had been mention too of Boyle and his treatises. Oldenburg in his next letter[2] asks concerning Huygen's pendulum clocks and also concerning the *Dioptric* and the *Treatise on Motion* which Huygens had intended to write. There is an obvious lacuna in the correspondence at this point: Spinoza seems to have answered Oldenburg's questions since in the next letter we have of Oldenburg he says, "When you speak of Huygen's *Treatise on Motion* you intimate that almost all the Cartesian rules of motion are false".[3] Oldenburg inquires once more in this letter concerning Huygen's pendulum clocks and his trip to France. Spinoza protests in reply that it was Huygens and not he who had found fault with the Cartesian laws of motion: he personally objected to only the sixth and on that one he thought Huygens was as much in error as Descartes. He asks concerning the experiment performed at the Royal Society in this relation, and adds some information concerning Huygens' method of grinding and polishing Dioptric lenses but he finds no advantage in that method; of his pendulum clocks and his trip to France he has no certain information.[4] Oldenburg confesses[5] that he does not understand the criticisms of the Cartesian laws of motion and asks for the precise particulars in which Spinoza differs from Descartes and Huygens; he, in turn, was not present with the Royal Society when Huygens performed his experiment in confirmation of his hypothesis, but he sends a description of it, then asks for further information concerning Huygens' success in grinding and polishing telescopic lenses. Here again the corres-

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Spinoza expresses his doubts concerning the possibility of explaining the phenomena of the comets by the Cartesian hypothesis in Epistola XXX (IV, 166); Oldenburg retails in reply (Epistola XXXI (olim 14); IV, 168) other astronomical intelligence, such as that all astronomers were then agreed that it was two comets and not one, but he had not yet come upon an explanation of the phenomena according to the Cartesian hypothesis; Epistola XXXII (olim 15) (IV, 176) closes with a note in which Spinoza asks if astronomers hold that the comets moved according to Kepler's hypothesis or by their own motion: Oldenburg appends a postscript to Epistola XXXIII (olim 16; IV, 179) promising that he will send shortly the opinion of British philosophers concerning the recent comet. This is the last letter before the second interruption of the correspondence, for ten years this time.

[1] Epistola XXVI (olim 13) IV, 159.

[2] Epistola XXIX; IV, 165.

[3] Epistola XXXI, (olim 14) IV, 167. The probability of a lacuna is increased by the fact that the fragment which stands in the Gebhardt edition as Epistola XXX did not figure in earlier collections of Spinoza's letters, but was an extract quoted by Oldenburg in a letter to Boyle. It is to be found in *The Works of the Honourable Robert Boyle*, London, 1772, vol. V, p. 339, from which it was first quoted by Willis, *Benedict de Spinoza*, pp. 244-6.

[4] Epistola XXXII (olim 15) IV, 174-175.

[5] Epistolas XXXIII (olim 16)

pondence is interrupted and the detailed modifications of the laws of motion are never given. There are still other details of scientific problems and method which enter Spinoza's letters from time to time. His own pronouncements and those of his correspondents run the whole length from acute estimations of scientific procedure to naïve narratives of interesting incidents and strange cases, and it is perhaps significant of Spinoza's doctrine that it permitted, with no contradiction, on the one hand the nicely mathematical treatment of physical problems of the *Principles of Descartes' Philosophy* and the *Ethics*, and on the other a theoretically justifiable excitement over a reported transmutation of silver to gold.[1]

There can be no question of Spinoza's intelligent interest in the scientific advance of his age. But that interest is determined, naturally, by the interpretation he puts on nature and the relevant solutions which experimentation might be expected to evolve.[2] The ideal of science is rational, and consequently knowledge of the nature of things may be attained by reflection concerning essences; experimentation could reveal nothing essential concerning things. "Only accidental qualities which are never clearly understood unless the essences of things are previously known", can be discovered by methods of observation.[3] The methods of proceeding of empirics and recent philosophers consisted almost wholly of attempts which neglected that truth. Truth and the knowledge of things do not take their validity from experience

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[1] Epistola XL (olim 45) to Jelles; IV, 196-197; the transmutation had been performed by one J. F. Helvetius, author of *Vitulus Aureus* which is concerned with subjects kindred to gold-making and the philosopher's stone. Moreover, Spinoza persisted in his belief despite the ridicule of one Vossius mentioned in the letter.

[2] Neglect of this and a persistently experimentalist turn in his critics have done much to prevent a proper appreciation of Spinoza's scientific opinions. Thus Martineau, says (*A Study of Spinoza*, p. 65 f.) "In truth, Spinoza's physical knowledge does not seem to have been so accurate or so large as his opportunities would lead us to expect. The reflective tendency of his genuis did not permit him to pause with long patience upon the analysis of concrete facts, but hurried him away into the region of large conceptions (generals that had never been generalized) whence, as he believed, he could see them brought to the birth". This he illustrates by misinterpreting the controversy with Boyle, by mistranslating the letter on Descartes' explanation of the rings of Saturn, and finally by insisting that Oldenburg asks more questions that Spinoza answers, adducing particularly his ignorance of Huygen's pendulums but scarcely noting that Huygens had removed to Paris and that the letter in question (Epistola XXXIII (olim 16) is saying precisely that Spinoza has no news either of his trip nor of the success of his experiments. We have moreover a letter of Oldenburg's (*The Works of Robert Boyle*, London, 1772, vol. VI, p. 200) in which he seems to be better pleased with Spinoza's reply than Martineau; he writes, October 10, 1665, that Spinoza "hath very lately written to me concerning M. Hugyens transmigration into France, his pendulums and his progress in dioptrics, etc".

[3] *Tract de Int. Emend.* I, 9.

or from the warrant of experimentation. If it were not for the fact that one clear and distinct perception or several clear and distinct perceptions taken in conjuncture can be the cause of others, there would be no search for truth and no possibility of attaining it. But our nature involves, as its very essence, some clear and distinct perceptions; the whole process of knowledge consists of evolving by a deductive or synthetic method, the body of truth implicated in them. Any consideration of method must start with this recognition and if science is to be significant and attain to certainty, it must be formed about this principle. Clear and distinct perceptions share in the surety and stability of eternal and essential natures, since they have a metaphysical foundation; but all experience and experimentation is involved in the change and vicissitudes of bodies. ". . . One clear and distinct perception or several together can be the cause absolutely of another clear and distinct perception. In fact all the clear and distinct perceptions which we form can arise only from other clear and distinct perceptions which are in us nor can they acknowledge any cause exterior to us. Whence it follows that the clear and distinct perceptions which we form depend on our nature alone and on its certain and fixed laws, that is, on our absolute power, and not on fortune, that is, not on causes which although they act by certain and fixed laws are nevertheless unknown to us and alien to our nature and power. As regards other perceptions, I confess that they depend chiefly on fortune. From these things appears clearly what sort the true method ought to be and what it should consist in chiefly, namely, in the knowledge alone of the pure understanding and of its nature and laws, in order to acquire which it is necessary before all to distinguish between the understanding and the imagination, or between true ideas and other ideas, namely fictitious, false, doubtful, and absolutely all that depend on the memory alone".[1]

To make these necessary distinctions requires no preliminary investigation of the mind; so far as method is concerned, all the critical preparation that is needed can be accomplished by putting together a short history of the mind or of its perceptions. Such a history had been made by Bacon, but Bacon had not, for that, come upon the true method since he shared the errors into which Descartes had fallen. Both had misconceived the first cause and origin of things, the nature of the human mind and the true cause of error. And as the Cartesian method fails because of these confusions, so too Bacon's errors concerning the mind lead him to a mistaken method. "Concerning Bacon I shall

[1] Epistola XXXVII (olim 42) IV, 188-9.

say very little, for he speaks very confusedly about this thing (the true cause of error) and he proves almost nothing but simply narrates. For in the first place he supposes that the human understanding, besides the fallibility of the senses, errs from its nature alone, and that it fashions all according to the analogy of its own nature and not according to the analogy of the universe, so that it is like a mirror which is inconstant to the rays of things and which mixes its own nature with the nature of things, etc.

In the second place, that the human understanding is prone to abstraction by its own nature and that it feigns things which are constant to be fluid, etc. In the third place, that the human understanding augments and can neither pause nor acquiesce. The other causes which he assigns can all be reduced to one of Descartes, namely that the human will is free and broader than the intellect, or as Bacon puts it more confusedly,[1] that the intellect is not of dry light but receives an infusion from the will".[2]

Bacon's method and Descartes' method are both wrong for exactly the same reasons though their methods are widely different. Descartes had misconceived the nature of God and of his infinite attributes so that he could take up the intelligible interrelations of things only by way of a causal derivation from God; he could form no notion of the identity of the sequence of ideas and things. He was nevertheless aware that the soul must begin with clear ideas and proceed deductively among clear ideas; his error was to imagine that God was the transeunt cause and not the immanent cause of things; he realized that things are intelligible in that they flow from God but he seemed unaware that they would then express an eternal essence. Bacon erred in another direction; he was not like Descartes a rationalist but imagined that the elements of knowledge come from the ordering of experience, that error consequently is an imperfect reflection of something outside the mind and that the very nature of the understanding committed it to falsification, since it must express a changing reality in constant terms. Spinoza's method was to be neither of these. What it was to be is sufficiently evident from the repeated and careful statement, not only of his method itself, but of his attitude toward experimental science. It is unmistakeable from his insistence alone that no reliable information could come to us from experience.

The place and relative importance of experimentation and of reason are stated most emphatically in Spinoza's correspondence

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[1] Vide Verulamii *Novum Organum* lib. I, Aphorismo 49.

[2] Epistola II; IV, 8-9.

with Oldenburg concerning Boyle's *Treatises on Salt-Petre* and on the *History of Fluidity and Firmness*. What Boyle's intentions were in these works is clear; in fact they were published under the joint title *Some specimens of an attempt to make Chymical experiments useful to illustrate the notions of the Corpuscular Philosophy*. They involve, as the preface avows, a plea for experimental study, addressed to philosophers who " are troubled when they see a man, acquainted with other learning, countenance by his example sooty empirics, and a study, which they scarce think fit for any but such as are unfit for the rational and useful parts of physiology ".[1]

It is a project to which Spinoza might be expected to attribute little philosophic importance, and in fact the politic and assiduous Oldenburg, when he received Spinoza's long critical reply to his request for criticism of the work[2] felt that he must have omitted to send some bit of explanation with the book. Thanking Spinoza for his kindness[3] he had to insist " meanwhile I want you to be advised that he (Boyle) set out not so much to show that this was a truly philosophic and perfect analysis of Nitre, but to point out that the popular doctrine and the one accepted by the schools concerning substantial forms and qualities rests on so little and that what they call the specific differences of things could be reduced to the magnitude, motion, rest and situation of parts. Having noted which the author says further that his experiment on nitre shows sufficiently and more than sufficiently that the whole body of Nitre was translated by chemical analysis into parts differing from each other and from the whole, and that later they coalesced again and were redintegrated so that very little of the original weight was lost ". In reply Spinoza thanks him for the transmission of Boyle's answer and the restatement of his purpose, although they were made only by the way and as if the questions which were raised were somewhat different (quamvis obiter, et quasi aliud agendo), but, he remarks a little dryly, these observations of his are not of such weight that the Learned Gentleman should expend time on them which might be used in more lofty speculations. " But I did not think ", he goes on,[4] " rather I could not have persuaded myself that the Learned Gentleman had no other end in his Treatise on Nitre than only to demonstrate that pucrile and trivial doctrine that substantial forms, qualities, etc., rest on so little; but since I had peruaded myself that the Honorable Gentleman wished to explain to us the nature of Nitre,

[1] *The Works of the Honourable Robert Boyle*, London, 1772; vol. I, p. 354.

[2] Epistola VI; IV, 15 f.

[3] Epistola XI (olim 8); IV, 48.

[4] Epistola XIII (olim 9); IV, 64.

that namely it was a heterogeneous body made up of fixed and volatile parts, I wanted in my explanation to show (which I think I showed sufficiently and more than sufficiently) that we can explain all the phenomena of Nitre, at least all that I know, even if we do not concede that Nitre is a heterogeneous body but a homogeneous one". This is wholly a question of whether experience can determine anything relevant to the ultimate constitution of things. That Spinoza jeers at Boyle's attempts to dispose of substantial forms, does not mean that he wishes to defend them, but rather he was convinced that reason had disposed of them long before. It was, in fact, the ancient atomists, Epicurus, Democritus and Lucretius who showed the futility of "occult qualities, intentional species, substantial forms and a thousand other vain trifles".[1] But for proof or disproof of them, for any valid consideration of such problems, it is reason and not the imagination which must be invoked.

The opposition between the experimentalist attitude and this rationalism is stated sharply each time Spinoza finds it necessary to consider the methods of experimentation. In an age that glorified itself for having discovered the importance of observation and that had worked itself rapidly to the belief that all the secrets of nature may be forced out by manipulation of things, Spinoza held strictly to the requirements of rational speculation. His confidence in the mathematical method is only a symptom of his attitude; that all truths are so related to each other that they may be derived from a few postulates; that the method of discovering the nature of things is to proceed carefully and on adequate warrant of inference from clear and simple ideas to others implied in them; and that the ways in which things affect the senses can reveal nothing of their nature. His attitude in the discussion of Boyle's experiments is dictated by this reliance on reason. Does experimentation convince the scientist that a chemical substance is made up of parts which possess different characteristics? Spinoza asks immediately what advantage is derived from that explanation; the opposed postulate that the parts are homogeneous would serve as well. His mathematical training alone would have suggested that he raise that query: to explain a thing, it should be a question of its nature, not of the history of its construction or of its effect on the senses—a parabola is described as a conic section no matter how it may happen to have been constructed or how it may appear to the inspector. Simply by following the mathematical method he would have been decided to abandon

[1] Epistola LXI (olim 60); IV, 261.

the attempt to discover the causes which led to the actual production of any particular thing; such causes may explain the accidental presence of the thing and its existence, but it will not touch on its nature or essence. The interest of mathematics is to discover the cause which will explain the essence of the thing however it may have been produced. Parabolas are treated as conic sections, not because all parabolas are constructed from truncated cones—clearly they are not—but because such treatment leads to the discovery of the essential characteristics of parabolas. So in the sciences, a good explanation need not follow an experimental illustration, it may represent nothing of the actual antecedent causes of a phenomenon, it may be frankly impossible to reproduce, but if all the qualities of the thing can be deduced from it, it is a good explanation. The phenomenon is not defined by the accidents of its occurrence; there are in fact innumerable hypotheses which could explain it correctly (since explanation is nothing more than a way to account for the essence of a thing in any imaginable circumstances) so long as the explanation appeal to fundamental laws, such as, in the case of extension, those of motion and rest.

The difference between Boyle and Spinoza is, then, this very profound methodological disagreement. Not only, however, is the approach of Boyle different from Spinoza's and not only is the appeal to experimentation as final verification the clear sign to Spinoza of jumbled thinking and of insufficient consideration of metaphysical fundaments, but the solution which is finally reached by experimentation is in most cases, as in this, needlessly complicated, and consequently experimentation alone leads almost inevitably to bad hypothesis. These differences between the two appear first in the problems involved in the redintegration of Nitre from the spirit of Nitre. Boyle had insisted that the spirit of nitre was not truly nitre, since it would not chrystallize nor could it be reduced to solidity or consistency, that is, it could not be changed to nitre without the presence of a lixiviate salt; consequently he looks on nitre and spirit of nitre as two separate substances. Spinoza insists there is nothing in these circumstances to confirm the conclusion. "In order that this be clear", he goes on, "I shall set forth briefly what suggests itself most simpy for the explanation of this redintegration of Nitre; and at the same time I shall adjoin two or three extremely simple experiments, by which this explanation is in a certain measure (*aliquo modo*) confirmed. To explain this phenomenon as simply as possible I suppose no other difference to exist between the spirit of nitre and Nitre itself than this one, which is manifest enough, namely, that the particles of the latter are at rest, while those of the former are moved by no

little agitation, one against the other".[1] The difference between Nitre and the Spirit of Nitre is then only in the motion of their particles, and the redintegration of Nitre is explained by the consistency of the particles of spirit of nitre, which are brought to rest through the agency of a fixed salt; this salt is used only as an instrument to that end. The same explanation by the movement of component particles will serve to explain other differences, such as the difference in taste of the two and the fact that Nitre is inflammable and spirit of nitre is not.

The point to be established is a very simple one and consequently the experiemnts are, as Spinoza observed, very simple. First he undertook to prove that the particles which go forth in the smoke when nitre is detonated are pure nitre. He heated nitre in a crucible, detonated it, and caught the fumes in a glass, dampened them by breathing on them, then left the glass to dry. Crystals of nitre appeared. But lest it be suspected that these were not formed from the volatile particles, but were instead particles of undecomposed nitre, expelled by the explosion, he fashioned a long tube and conducted the fumes from the experiment to a mirror. To it, he said, "a certain matter adhered, which when exposed to air liquified and, although I waited several days, I was able to observe no effect of nitre; but after I poured Spirit of Nitre on it, it was changed to Nitre".[2] This appears, to the sensibilities of the experimentalist, a rather cavalier fashion of distorting experiments to one's preconceived purpose.[3] Yet Spinoza considered that this experiment, like the two which are to follow is sufficient to prove his point (and it would be rather difficult to imagine what an experimental disproof of it would be) that the whole phenomenon can be explained in terms of fixed and volatile parts of a body operating in accordance with the laws of motion; moreover, he contends parenthetically, it is senseless to try to show that this explanation is faulty, but Boyle's explanation based on a radical distinction of nitre and its spirit into two wholly different bodies, is needlessly complicated and so, a bad explanation. Spinoza suggests one interpretation of his experiment: "From this I seemed able to conclude, first, that the fixed parts were separated in liquifying from the volatile parts and that the flame forced them, after they had been dissociated from each other, together again. Second, that after the fixed parts are dissociated from the volatile by detonation, they can not be untied again: from which it is

[1] Epistola VI to Oldenburg; IV, 17.

[2] Epistola VI to Oldenburg; IV, 22.

[3] Cf. for example the righteous indignation of Couchoud, *Benoit de Spinoza*, p. 81, ff.

concluded, thirdly that the parts which adhered to the vessel and coalesced into crystals were not fixed but volatile ".[1] The other two experiments are conceived to the same end. The second seems to show that the fixed parts are only the *faeces* of nitre and that the more that nitre is freed of *faeces* the more volatile it becomes and the more apt to crystallize. To show this, he very simply dissolved filtered nitre in cold water and as the water evaporated, crystals of nitre were found on the sides of the glass. The third experiment attempted to explain why Nitre is inflammable and the spirit of nitre is not; the particles of the spirit of mitre are in motion; when they lose their motion they become inflammable again. This, he illustrates by mixing sand and spirit of nitre, drying them and putting a glowing coal to them. They took fire and sparkled in the same fashion as Nitre would have if it had been present.

It cannot be insisted too much that these experiments are not carried on in ignorance of the proper controls of scientific experimentation, but that rather they are dictated by a profound theory of what is involved as a postulate in all experimentation. The contrast of the attitude Spinoza assumed and the customary dogmas of experimentalism could not be brought out more clearly than they are in his discussion with Boyle. Boyle is concerned everywhere with the advance of the experimental method and he undertakes in several sections of his treatise to demonstrate that the tangible and other qualities of Nitre and spirit of Nitre, such as heat, sound, colour, taste and others, depend on the motion, figure and mechanical modifications of their particles. To demonstrate each of his contentions he advances a carefully devised experiment, and clearly it is this precise experimental illustration which is the chief end he sought. Spinoza looks upon them otherwise; "since they are not advanced by the Honourable Gentleman as mathematical, there is not need to examine whether they are directly conclusive. But meanwhile I do not understand why the Honourable Gentleman should try to solicitously to collect this from his experiment, since it was demonstrated sufficiently and more than sufficiently first by Bacon and then by Descartes ".[2] The point is not that Bacon or Descartes had experimented with Nitre, but if it is a question of demonstrating that sensible qualities are the result of motions of parts, there is no need to observe the heat and agitation which result from mixing lime and water; rub two pieces of wood together and you have heat; or if it is a question of producing sound, boil water; and so

[1] Epistola VI; IV, 22-3.
[2] Epistola VI to Oldenburg; IV, 25.

for all sensible qualities. Boyle believed that the experimentalist should proceed in laborious exploration of the whole realm of nature; Spinoza insisted that experimentations could discover only examples of the workings of universal laws; those laws and their implications must be followed out rationally and consequently any experiment was practically as good as any other. "And so", he said, "was I to judge if a philosophic freedom may be used all these things to be superfluous (supervacanea)? I say this lest others who love the Honourable Gentleman less than they should, judge falsely concerning him".[1] Spinoza's inquietudes on this score take a strangely ironical note from the subsequent history of thought.

II

The differences which have appeared in this controversy are not accidental, nor are they limited to or dictated by only a controversy over Nitre. Ultimately there are involved theories of knowledge, and real point of difference centres on the place of experimentation. Boyle opens his *History of Fluidity and Firmness* in the vein of such reflections: "Whether philosophers might not have done better in making fluidity and firmness rather states than qualities of bodies, we will not now examine. But under which soever of the two notions we look upon them, it is manifest enough that they are to be reckoned amongst the most general affections of the conventions or associations of several particles of matter into bodies of any certain denomination, there being scarce any distinct portion of matter in the world, that is not either fluid, or else stable or consistent".[2] Spinoza would of course question whether it is manifest enough that they are to be numbered thus. "Notions" he said, "made for the popular use, or which explain nature not as it is in itself but as it refers to human senses, I judge should in no fashion be numbered among the summa genera nor should they be mixed (lest I say confounded) with pure notions and notions which explain nature as it is in itself. Motion, rest and their laws are of this latter variety; visible, invisible, hot, cold and, to say it forthwith, fluid, solid and others are of the former".[3] And when Boyle remarks[4], "It would scarcely be believed, how much the smallness of parts may facilitate their being easily put in motion, and kept in it, if we were not able to confirm it by chymical experiments", Spinoza must express himself definitely on this ignorance

[1] Epistola VI; IV, 26.

[2] *The Works of the Honourable Robert Boyle*, vol. I, p. 378.

[3] Epistola VI; IV, 28. Cf. *Princ. Phil.* Pars. II, 1; I, 186. Quamvis durities, pondus, et reliquae sensiles qualitates a corpore aliquo separaentur, integra remanebit nihilominus natura corporis.

[4] *The Works of the Honourable Robert Boyle*, vol. I, p. 380.

of the limitations of experimentation. " Never ", he said, " could any one prove that by chemical nor by any other experiments, but only by demonstration and computation. We divide bodies in infinitum by reason and by calculation, and consequently we also divide the powers that are needed to move them; but we could never prove it by experimentation ".[1]

It is not surprising then that Spinoza should protest constantly in the course of Boyle's demonstrations that his experiment is either unnecessary or insufficient to demonstrate his contention. Many of the experimental conclusions could be known by more simple processes; there experimentation is unnecessary; others go contrary to essential truths known rationally and adequately: experimentation is insufficient to overthrow or even touch them. Thus Boyle experiments with the action of *aqua fortis* on silver to demonstrate the action of insensible parts which are themselves seldom visible to us. That action could be known sufficiently, Spinoza thinks, by observing the behaviour of one's breath on a cold day. Experimentation will give you no new truths about the nature of things; but if it will limit itself to compiling the histories of things it may be extremely useful. So in the question which interests Boyle, that of fluids, the explanation rests on very simple grounds. " Finally, to bring this up incidentally, it suffices for the understanding of fluid *in genere*, to know that we can move our hand with a motion proportionate to the fluid in all directions with no resistance as is manifest enough to those who attend sufficiently to those notions which explain nature as it is in itself and not as it is related to the human senses. However, I would not despise this history as useless, but on the contrary if it were carried out for each liquor as accurately and with as great good faith as possible, I should deem it extremely useful for the understanding of their peculiar differences, a thing very greatly to be desired by all philosophers as most necessary ".[2]

Briefly and definitely then, knowledge does not come from experience; experimentation can not in the nature of things lead to a knowledge of what things are. Only by reason can truth be reached, and reason derives its true ideas not from memories or experiences but only from other true ideas. Experimentation can decide nothing concerning the truth or falsity of an idea, for that depends on a demonstration of which only the mathematical statement is adequate; an appeal to experience is irrelevant to any mathematical consideration. Experience deals with events, not with ideas, and it is relevant to reason only in that

[1] Epistola VI; IV, 29.
[2] Epistola VI; IV, 33-34.

it can indicate whether things actually exist in one relation rather than another. Experimentation, in other words, can tell what reasoning is relevant to a situation, but it can not be an arbiter of truth. It can indicate what relations need not be thought about, because they are irrelevant, but the actual processes of scientific thought ignore experience: no true ideas come from without us; so long then as science is concerned with the external and accidental relations of things it will reach no certainties; we have only inadequate ideas of particular bodies and particular souls, whether they be our own or others. Yet accurate science is possible, because science is concerned, not with existences, but with essences or at least with general notions. It is possible to know what a thing must be; to know what it is, is a rare achievement and does not fall in the domain of science.

Experience is equally irrelevant to knowledge of chemical substances and of God. De Vries once asked Spinoza if experience is needed in order to know whether the definition of any attribute is true or not, and Spinoza's answer was categorical. "We never need experience, except for those things which can not be concluded from the definition of a thing, as for example, the existence of modes: that can not be concluded from the definition of a thing. Certainly not for those things the existence of which are distinguished from their essence and is concluded consequently from their definition. Indeed no experience can ever teach us that: for experience teaches us that essence of no things; but the most which it can affect is to determine our mind to think only concerning certain essences of things. Wherefore since the existence of attributes does not differ from their essence, we will be able to reach it by no experience".[1]

It is not to be expected, however, that an avowed empiricist would fall in which a view that experimentation is merely a way by which thought fixes upon one among many conceivable and possible entities. Boyle protests through the omnipresent Oldenburg against the obvious violations of the canons of experimentation which Spinoza committed. Spinoza's theory is essentially that the fixed salt of nitre is only the faeces of spirit of nitre and that the differences of their behaviour can be explained by the fact that the spirit of nitre is relatively pure of *faeces* and is a more subtle matter since its particles move more rapidly; these *faeces* have motions hollowed out to the measure of the particles of nitre. This supposes a subtle matter in which a more gross matter is lodged, and whereas Boyle objected to all the suppositions which Spinoza set up, this one seemed to him particularly obnoxious; it was assumed,

1 Epistola X (olim 28) to De Vries; IV, 47.

he said, simply from the hypothesis of the impossibility of a vacuum rather than proved necessarily from any phenomena. Such a fault is inexcusable in the eyes of Boyle since his concern is almost wholly with illustrating and utilizing the experimental method. He is, as Oldenburg expresses it, for him, of the number of those who are not so confident of their reason that they do not want phenomena to agree with reason. Experimentation, he is sure, will lay bare the laws of nature. He protests consequently against any tendency to identify nitre and the spirit of nitre since he must insist that they differ in chemical and physical properties. He contends that each of Spinoza's experiments was conducted under improper conditions, so that in the first, the crystals of nitre are to be explained by the particles of nitre which escaped in the detonation, in the second by causes which have nothing to do with the question and in the third the sparkling is to be accounted for by the solid, rigid particles of the salt.[1]

The precise issues of the opposition then are stated definitely and clearly. Spinoza has insisted that Boyle's experiments are unnecessary; Boyle has protected that Spinoza's reasonings are hypothetical and irrelevant. Boyle is outraged most of all that Spinoza should suggest the substitution of simple experiments for his nicely articulated ones. There is, he points out through Oldenburg, a great difference between experiments in which every element that enters is definitely known and the obvious experiments in which it is not known what Nature contributes and what slips in unchecked and unobserved. Thus wood is a much more composite body than the subject Boyle treated and the burning of wood to produce heat is a complex phenomenon; Spinoza commits the same error there as when he suggested the boiling of common water, for fire is added externally, whereas in the procreation of sound, with which Boyle worked, the agitation and movement is caused by nothing external. But Spinoza retorts to this that Boyle has misconceived his contention: he had protested against the presumption of this experimentation. Bacon and Descartes too were men who wanted phenomena to agree with their reason, but possibly, since the Illustrious Gentleman did not find his theories stated and treated clearly in the works of others before him, he has something, which Spinoza confesses himself unable to find, which refutes their work. This Spinoza is willing to suppose since all men may err, but as to the great difference between the obvious and the dubious experiments he had used, he confesses that he does not see that the Illustrious Gentleman has explained the nature of the things used, namely

[1] Epistola XI (olim 8) from Oldenburg; IV, 49 ff.

the calx of Nitre and the spirit of Nitre, so that they seem less obscure than the things he used, namely common calx (lime) and water. As to the wood, he concedes that its nature is more composite, but he asks what difference that makes since in both cases they are ignorant both of the nature of the things involved and of the mode in which heat arises. So, definitely through this discussion it continues to be a question of what contribution experience can make.

So far as expriments are concerned Spinoza insists that the hypotheses of Nitre as made up of heterogenous or of homogeneous parts are equally well-founded, and on experimental grounds there can be no choosing between them. Since Boyle had stated that experimentation favoured peculiarly the explanation of Nitre and spirit of Nitre as two distinct substances, explicable by their physical and chemical behaviour, he had proposed to try whether that behaviour could not be explained as well by the opposed supposition that they are fundamentally the same substance. In fact, he said, " concerning this, it was not my purpose to show that the fixed salt is the *faeces* of Nitre but only to suppose it, that I might see in what manner, the Illustrious Gentleman could show me that the salt is not the *faeces* but rather that it is necessary to constitute the essence of Nitre without which it can not be conceived ; because, I say, I thought that the Illustrious Gentleman wanted to show that ".[1] Spinoza has at most a sceptical reaction to the attempt to show by chemical manipulation that Nitre is a heterogeneous body made up of fixed and volatile parts. So he fits all of Boyle's objections into his explanation. He protests that his hypothesis is perfectly adapted to explain the redintegration of Nitre, for the fixed salt of Nitre (or the *faeces*) has motions hollowed out to the measure of the particles of Nitre ; when Boyle points out that experimentally other salts can effect that redintegration, Spinoza replies that then, obviously, they have motions approximating those of the fixed salt of Nitre. Consistently, in other words, Spinoza is reiterating that as explanations, hypotheses can have only rational foundations, and substantiation of criticism of them must be derived from reason. In a profound metaphysical sense, scientific hypotheses have only an accidental relation to experience. Consequently he was very much surprised that Boyle should have sought to invalidate his hypothesis at this point by showing that it is not founded on phenomena in the empirical fashion, but rather that it follows from an assumed impossibility of a vacuum. " In the nezt place ", he says, " what I said concerning the particles of nitre in greater motion surrounded by more subtle

[1] Epistola XIII (olim 9) to Oldenburg ; IV, 65.

matter, this, as the Honourable Gentleman notes, I concluded from the impossibility of a vacuum; but I do not know why he calls the impossibility of a vacuum an hypothesis, since it follows clearly from this, that Nothing has no properties. And I wonder that the Illustrious Gentleman should doubt this, since it seems to be established that there are no real accidents present (in a vacuum): I ask whether a real accident would not be present if there were quantity without substance?"[1]

The three experiments then which Spinoza used to confirm his explanation were not, since they could not be, absolute confirmation of it. "Indeed, as I said expressly, I did not bring forward these experiments that I might confirm by them that which I said: but only because these experiments seemed to confirm in a certain manner (aliquo modo) that which I said and that which I showed to agree with reason".[2] The important thing, of course, was that the explanation was founded on good reasons, and that it was derived only from the implications that follow from clear and distinct ideas. Experience can never furnish a true idea; experience cannot wholly fail within a true idea nor wholly contradict it; but it may be analysed to illustrate a clear and distinct idea. If Oldenburg interprets Boyle's ambitions correctly however, sections of the treatise on Nitre were written "to demonstrate and insist on the use of Chemistry for establishing the mechanical principles of Philosophy"; it was this which Oldenburg had in sisted that Boyle could not find stated or treated clearly in any work.[3] That Spinoza had invoked the name of Bacon and Descartes was not a defence of former experimentation, but a reflection concerning experiments: this experiment, like all others, will reveal nothing of the mechanical principles of philosophy, but if the mechanical principles are known, then this is a good experiment to investigate the nature of Nitre. "I say that I confess freely that this redintegration of Nitre is a fine experiment for the investigation of the very nature of Nitre, when, of course, we first know the mechanical principles of Philosophy and when we know that all variations of bodies are made according to the laws of mechanics; but I deny that they follow more clearly and obviously from the aforesaid experiments that from many other obvious experiments from which they are not demonstrated".[4]

One might return then to the distinction which Boyle made between experiments which are conducted under proper controls

[1] Epistola XIII (olim 9); IV, 65. Cf. *Prins. Phil.* Pare II, 3; I, 188.
[2] Epistola XIII (olim 9); IV, 66.
[3] Epistola XI (olim 8); IV, 50.
[4] Epistola XIII (olim 9); IV, 67.

so that all the elements that enter are known and other common experiments. Spinoza doubts whether that distinction can ever be sharp enough to make much difference philosophically. " Finally, he says, " I do not know on what grounds the Illustrious Gentleman dares to affirm that he knows what Nature contributes in this matter concerning which we are speaking. On what reason can he show us that this heat has not arisen from some extremely subtle matter? Possibly because little of the original weight was lost? Even if nothing had been lost, nothing could be concluded in my judgment: we see, in fact, how easily things can be imbued with some colour from only a small quantity of matter and so, as far as the senses are concerned, are made neither heavier nor lighter. Wherefore I can doubt, not without reason, whether perchance certain things do not concur which could be observed by no sense; certainly so long as it is not known how all those variations which the Illustrious Gentleman observed in experimenting, could be performed by the aforesaid bodies, by all means I hold it for certain that the heat and that effervescence of which the Illustrious Gentleman speaks have arisen from an adventitious matter ".[1] The particular problem to which Boyle had attempted to give experimental demonstration requires no principles other than those which Spinoza uses constantly to explain fluid bodies; the experimentation has only shown this problem to be one of those that fall in this well-known explanation. " For I am compelled by the experiments this far to recognise no other difference between the spirit of nitre and Nitre than that the particles of the latter are at rest while those of the former are in a state of great mutual agitation: so that there is the same difference between Nitre and its spirit as there is between ice and water ".[2]

Such a statement must appear to Boyle, as to Oldenburg, a distinct misconception of the investigation. Oldenburg consequently undertakes in his reply, first to restate definitely the originality of Boyle's methods, and then to show that there is no genuine disagreement between him and Spinoza. Both of these well-meaning attempts go back to that reiterated emphasis on the experimental method. Boyle, Oldenburg writes, " asks that you consult the preface to his experiment on nitre that you may understand from that the true scope which he set for himself in that work; that is, to show that the principles of the more solid resurgent philosophy are illustrated by clear experiments and that they can best be explained without the forms, the qualities and futile elements of the schools; but in nowise did he undertake to teach the nature

[1] Epistola XIII (olim 9); IV, 67-8.

[2] Epistola XIII (olim 9); IV, 68-9.

of nitre or to reject those things which can be concluded concerning the matter, homogeneity and differences of body from motion and figure, etc., so far as they proceed from any of these. He says that he wished to introduce various textures of bodies and various differences between them to the extent only that diverse effects follow from them, and with reason therefore, so long as no resolution to primary matter has been made, some heterogeneity is concluded by philosophers and others".[1] For the rest of the letter Oldenburg is concerned with exhortations that Spinoza cooperate with Boyle, with reiterations that at bottom they are saying the same thing, with remarks that Boyle had anticipated and could not admit such reasonings as were adduced about vacuum and with insistent demands for precise illustrations: an example of odourless bodies combining to form a body with an odour; if nitre and its spirit are related as water and ice how account for their discrepant qualities? Whether Spinoza tried to restate his position more clearly in the face of these repeated simplifications we are unable to say. The correspondence seems to have been interrupted by the war between England and Holland which extended from 1664-1667. In letter XXV written in April 1665 seems to be taking up the thread of correspondence after an interruption of nearly two years. But neither that letter nor Spinoza's reply to it resume the debate again. Yet it is highly probable that Spinoza had more to say, since letter XXIX of Oldenburg refers to Spinoza's letter of the fourth of Spetember; that letter seems at last to have convinced Oldenburg that Spinoza did not share his opinion. Oldenburg writes now to tell Spinoza that he has convinced not only him but also " our noble Boyle ", who sends his particular thanks. But though this discussion of the experimental method is the only important one (save the problem of the Dutch translation of Boyle's treatises into Latin) which Oldenburg and Boyle shared, it is impossible to judge was Spinoza convinced them of, since the body of Boyle's work in experimental science stands as convincing evidence that the precise bearing of this rationalist argument certainly escaped him. Moreover Spinoza figures in Oldenburg's letter to Boyle somewhat differently than one would expect from his letters to Spinoza. He is mentioned only once as " a certain odd philosopher whom you know, it being Signior Spinoza " who expresses his great respect and presents his most humble services.[2] It is probable that to Boyle's mind he continued to figure as odd and particularly odd

[1] Epistola XVI (olim 11); IV, 74.

[2] *The Works of the Honourable Robert Boyle*, London, 1772, vol. VI, p. 200.

in the strange criticisms he brought forward to the proceedings of experimentation.

The criticism of the experimental method follows in detail from the fundamental tenets of the Spinozist system. Knowledge derived by the senses is imagination and can by no process be metamorphosed into knowledge of substance which is reached by the intellect alone. The nature of things may be regarded by either of two means, the intellect or the imagination; experimental knowledge is by nature imaginative and like all imagination, though useful, doomed to be inaccurate. All considerations the mind can enter on may be divided between these two. So, " there are two ways in which quantity may be conceived by us; abstractly or superficially as we have it by way of the senses in the imagination, or as a substance, as it is known only by the intellect alone".[1] Only by the imagination is quantity separable, divisible, finite, and consequently it is subject to measurement, an indispensible device of experimentalism, only when it is conceived as abstracted from substance. So too duration can be determined only when separated from the manner in which it flows from eternal things. Finally only when the affections of substance are separated from substance itself and are reduced to classes that we may imagine them easily so far as that is possible, does number arise. Those favourite categories of the scientist, number, time and measure are therefore nothing more than modes of thinking or rather modes of imagining. All the antinomies of reason arise from confusing these categories with other notions which could never arise from the imagination but only from the intellect. The modes of substance, and these are the subject matter of science, can never be understood if they are confused with beings of reason or aids to the imagination such as time, measure and number.[2] The passing of an hour can not be explained if duration is conceived abstractly and confounded with time, for to try to build duration out of moments is the same as to try to build number out of zeros. The nature of things can not be seized adequately by instruments that measure or count.

This position is not so much a condemnation of experimentation as a limiting of it to its possible utility: it can serve to show that there are things or phenomena of a certain sort but it is inadequate to show what they are. On the other hand it is not to be supposed that particular things are known by a direct deduction from substance. Tschirnhaus was very much concerned that Spinoza

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1 Epistola XII (olim 29) to Meyer; IV, 56.

2 Cf. Epistola XII (olim 29); IV, 57-58.

demonstrate the existence of bodies *a priori* from the concept of extension,[1] but Spinoza replies that that is impossible.[2] Moreover, whereas a purely factual account would give nothing of the nature of a thing, a purely metaphysical consideration, if it were possible, would yield only the most general characteristics—motion in extension, understanding in the intellect. One aspect of this worried Tschirnhaus a great deal,[3] since it made it difficult to know what distinction there is between a true and an adequate idea. If he examine the cause of a given idea, he is led to another, and the cause of that is still another concept, and so on till he is led to a cause for which he can find no further cause than that among all the possible ideas which he had within him, this one alone existed. It is not far to seek the practical methodological aspect of the problem: since many things, each expressed in infinite modes, have adequate ideas of themselves, and since in each case all that can be known of the thing can be deduced from that adequate idea, and since finally the conclusions flow more easily from one such idea than from another, how shall it be decided which idea is the better?

This is in fact the problem which Spinoza would assign to the sciences. No hypothesis can be erroneous once the fundamental laws of mechanics are set down, but some can be more valuable than others, since more properties can be deduced from them and the process of deduction can be less laborious. "I assert absolutely, that from certain properties of anything (whatsoever idea be given) some things may be discovered more easily, others with more difficulty (all of which things regard the nature of the thing); I think it must only be observed that an idea of such a nature must be sought that from it all properties can be inferred".[4]

The obvious aim of science is to find such ideas that all the properties of the object may be deduced from them with as little difficulty as possible. And from that obvious aim is derived again the obvious fitness of the mathematical method for the investigation of the nature of things. Very little reflection is required to realize what would be expressed by such ideas in the Spinozist system, that is, in a world which is derived from an infinite substance by the mediation of infinite *naturae naturantes*: all the properties of a thing can be deduced from a definition of it by its efficient cause. This is true equally of circles and of God, and God enjoys in explanation only one superiority over other

[1] Epistolae LXXX and LXXXII (olim 69 and 71); IV, 331-333.

[2] Epistola LXXXIII (olim 72) to Tschirnhaus; IV, 334)

[3] Epistola LIX from Tschirnhaus; IV, 269.

[4] Epistola LXI (olim 17) to Tschirnhaus; IV, 271.

things, that for him the efficient cause is internal rather than external, since he is cause of himself.[1]

This much of methodology, as in fact all methodological considerations, is determined by the nature of things. If a single fallacy were to be pointed out in the experimental method it is the primary assumption that Nature is such that a conception of its parts may be constructed by examining them in their operations and relations to each other. It is an important distinction that Spinoza considered Nature as a whole, that he did not think that it is determined by its parts, but rather that Nature determines the parts. By his conception any true idea carries implications concerning the whole, and for it to be true means that it is known in some relation to the whole, since each part pertains to the nature of corporeal or of thinking substance and can not be or be conceived without it. An explanation which is constructed from the observation of a few phenomena rather than from the universal principles of things ignores the nature of explanation. Even to consider a body so far as it exists, modified in a certain manner, it must be considered as part of the whole universe, agreeing with the whole and still cohering somehow with the other parts. Viewed in this way the whole of nature is the fluid concourse of infinite parts which impinge upon each other and determine each other to exist and to operate in certain ways. The nature of each part accommodates itself and agrees with the nature of other parts with which it comes in contact, modifying itself within the limits of its own nature in a fashion which will go least contrary to its nature. In all the parts, that is, in all the universe, the same relation of motion and rest is conserved. So far as the physical sciences are concerned, their explanations go back all to the principles of mechanics, to the laws of motion, for it is by motion and rest that all bodies are maintained in existence and are modified. This is at once the reason why and the manner how all bodies are parts of nature. It is significant for human behaviour that mind is part of nature in a way which will be seen to be the same as that in which the body is part of nature.[2]

It is superfluous to insist after such definite explanations, that Spinoza, far from standing in ignorance of the tenets of what we have come to call modern science, reiterated as clearly and as persistently as possible that it violated some of the primary requirements of good explanation, and that its error lay chiefly in that it neglected the role experience plays in thought. His objections,

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[1] Epistola LXI, ibid.

[2] Cf. Epistola XXXII (olim 15) to Oldenburg; IV, particularly 170 and 173.

which he details so specifically in his letters, are implicit in his metaphysics and his ethics. They might consequently have been sensed even by those of his critics who had not read his letters. Nevertheless this nicely reasoned criticism of science has been passed over and buried ; and the tragedy, further, is that even among his correspondents, Tschirnhaus seems to have been the only one to have grasped the full import of this attitude and to have asked pertinent questions concerning it. The dogma of the progress of science was evidently fixed so firmly at the very beginning of science that heresies about its apparent nature were submissively ignored. It was no easy task for the centuries since Spinoza to ignore these criticisms and yet raise his works to high philosophic esteem, for he stated again and again the exact nature of mathematical reason, he insisted that it was the one road by which reason might be lead to truth certainly, he composed two important works on the well-examined bases of such insistences and according to that method, and finally he entitled his one treatise on physical phenomena an *Algebraic Computation of the Rainbow*, added in the subtitle that it was for the *greater connection of physics and mathematics* and lest that prove insufficient, affixed the quotation from Cicero to the title page.[1] " Among them geometry was in the highest honour, and so none were more illustrious than mathematicians. But we have set the limit of that art to its utility for measuring and calculating ".

[1] *Tusculanarum quaestionum lib. I.* in princ.

THE MEANING OF THE COMIC

By RICHMOND H. HELLYAR

The core of the philosophy of laughter is, and always has been, the meaning of the comic. Philosophers, from Aristotle to Bergson, have always been fascinated by its elusiveness and, far too often, a definition of the comic has sufficed to "solve" the problem of laughter.

The variety of theories that have been evolved in the attempt to explain this mysterious quality of Nature is extraordinary. Ugliness, said Aristotle. Contrast; surprise and the unexpected; a descent from the large to the small; a form of the sexual; incongruity; interruption; rigidity and absentmindedness—these are some of the more reasonable, or more recent suggestions. But not one is altogether satisfactory.

You can make out a pretty and convincing thesis from any of them. And, for a few days, you will feel happy in the solution of a problem that has defied all analysis until you, or your chosen philosopher, tackled it. Sooner or later, however, things will occur that will make you feel just a trifle uneasy. Life is rich in the subject matter of your argument, and is perpetually throwing choice examples into your lap, which, unless you wilfully ignore them, demand their right to put you to the test. Eventually, as the examples begin to accumulate, you will probably grow more and more dissatisfied. And, finally, if you possess a little of that rigid impartiality which was Darwin's supreme gift, you will reject the onetime rosy idea as altogether useless.

There is only one way of testing the truth of a theory—a large body of facts. Elsewhere I have collected a list of chance comic occasions that have recently come within my experience. Learning from the errors of previous writers, I have taken care to remedy the fault of unconsciously choosing the facts that fit one's opinions. For a theory of the comic, to be of any value, must cover every funny fact. Every theory that has been put forward will cover some of the facts. But there is not one that is all inclusive.

The theory of laughter has suffered badly from this incomplete

survey of the comic field. There is, too, a noticeable absence of clear and definite application of theory to fact. The explanation that I give here claims one thing. It has a goodly company of comic facts behind it, i.e. facts that I have found funny; and it relates them with each other on a basis which, if it lacks sensation, does, at any rate, honestly covers the facts, without putting up any picturesque or literary symbols to serve as an " explanation " of them.

But, before I put forward my theory, I wish to devote some attention to a theory of the comic that is very popular at the present, and that suffers from this fault of substituting literary imagery and elusive metaphor for a definite explanation. The theory I mean is, of course, that of M. Henri Bergson.

To the vast majority of intelligent people to-day, laughter spells Bergson. Most of the readers of this essay will come to it with the ideas that Bergson has planted in them, and convinced that Bergson has explained the problem of the comic once and for all. This agreeable feeling of satisfaction at the supposed final solution of a very puzzling, if minor, problem of philosophy is, at the least, very premature. I am giving a good deal of space to an investigation of Bergson's theory of laughter, partly in order to disperse false convictions of belief, and partly as an introduction to what I have to say later.

Bergson's fame as a writer on laughter is not necessarily reflected in his wide circulation and many readers. All bookmen have Bergson on their shelves, if they have nothing more. He is accepted everywhere as *the* philosopher of laughter; his explanation is the only one that most people know. This popularity, however, is not directly dependent on the excellence of his reasoning, nor the truth of his conclusions. It is because he is Bergson, one of the most important European philosophers.

I suppose that there is no philosopher more widely read then Bergson; and, equally, none less understood. Bergson has gifts of imagination and poetic insight that are rare indeed among philosophers. It is undoubtedly on account of this rich imaginative appeal, his magnificent conception of Nature, and his impressive pictures of its action and processes, that his philosophy has so wide an appeal. It is not for the scientific truth of his argument that one reads him. The spirit in which one goes to Bergson is more one of splendid adventure. There is a desire to be swept away on the flood of his imagery to the glorious finality of a complete knowledge. And, although this finality never comes, and although one knows very well that it never will come, still one goes on.

Bergson may " never have added a single fact to biological

science", but he has certainly given many of us fresh visions of Nature, has unfolded something of the wonder that lies behind everything. And, dissatisfied as one may be with the all sufficient élan as a real explanation, one must agree with Dr. Julian Huxley that Bergson can convey a picture of the evolutionary process, that is unsurpassed in its vividness and imaginative insight.

Bergson's book on laughter is no exception. Although the subject is not so open to poetic treatment, and lacks the infinity of Nature as a whole, his essay contains some thrilling passages, and is, unlike all other books on laughter, with the exception of Meredith's, a work of art. But it is not only emotionally convincing. It is one of the most ingeniously contrived theories I have ever read, and is, moreover, finished with a precision that is altogether lacking in his wider subjects. He has woven his facts into a completely water-tight hypothesis. It will convince you against your will—at least for the time. It is this compactness that makes his theory seem so obviously correct. Not a sentence, nor an argument, appears out of place. Everything seems to fit perfectly. You feel, at any rate I felt, completely satisfied. Another problem done with!

It is only when you begin to think a little that its insufficiency dawns on you. It is its flawlessness that is the essence of its error. Its perfection is the perfection of the cameo; or, better, the perfection of a single column in a cathedral nave. For it only includes a fraction of laughter experience.

Bergson calls his book "Laughter: an essay on the meaning of the comic". Actually it is not about laughter at all. The laughing man, who should be at the very root of a theory of laughter, is neglected entirely, as is all the great area of laughter that lies outside of the comic altogether. For Bergson, indeed, laughter simply means the comic. The only mention of laughter, qua laughter, is when he tells us that it is devoid of "feeling"; and when he defines it as "a social gesture", a "corrective of behaviour". Although Bergson makes some sort of a system out of the combination of this (presumed) corrective power of laughter, and his general conception of the comic, it is on the objective side that he merits discussion.

His theory of the comic is, of course, well known. "The laughable element consists of a certain mechanical inelasticity ("une certaine raideur de mécanique") just where one would expect[1] to find the wide-awake adaptability and the living pliableness of a human being". "Automatism, *inelasticity*, habit that has been

[1] Note, even here, in his own definition, the necessity of "expect".

contracted and maintained, are clearly the causes why a face makes us laugh. But this effect gains in intensity when we are able to connect these characteristics with some deep-seated cause, a certain *fundamental absentmindedness*, as though the soul had allowed itself to be fascinated and hypnotised by the materiality of a simple action . . . ." " Something mechanical encrusted on the living ".

The essence of his theory is the imposition of stiffness, rigidity, artificiality, on the living. This is for him the comic ; and Bergson follows it up closely in his essay, applying it to a variety of instances, many of them hailing from French Comedy. The best of the book is, paradoxically enough, the essay on art ; and the best of the comic argument is in the first fifty pages. He grows dull as he advances, and the chapter on the comic in words, and in situations (i.e. French Comedy, mostly Molière), makes one suspect something underneath. But throughout the whole of his essay argument follows argument in natural succession to an apparently inevitable conclusion. It is a beautifully contrived structure, and is clothed in the rich imagination and glowing language that is present in all Bergson's work.

But, unfortunately, clearly conceived, and perfectly executed as it may be, it is really quite an unnecessary and arbitrary conception. Everything that Bergson concludes from his facts can be interpreted in another, simpler, and less metaphorical way. This holds, quite apart from the existence of other comic objects and occasions that are either impossible of explanation on Bergson's hypothesis, or only to be explained by a very elaborate, and perilously indirect argument.

One need not go outside the narrow limits of his own facts to discover the flimsiness of some of his subordinate ideas. For instance, why do we laugh at a negro? I don't think Bergson includes either himself, yourself, or myself under this " we ". Let us say, therefore, with greater precision, why does the small boy laugh at a negro? Because, replies M. Bergson, " a black face in our imagination is one daubed over with ink or soot . . . ", " and so we see that the notion of disguise (which his theory can cover) has passed on some of its comic quality to instances in which there is actually no disguise though there might be ". But eventually, apparently realising the entire lack of necessity for all this roundabout series of mental processes in the mind of the child, or peasant, he begs the question by saying that " there is a logic of imagination which is not the logic of reason ", and that this is the influence present in the laughter's mind.

This is all very bad. The " logic of imagination " is apparently

a logic that makes one believe in M. Bergson's theory. But logic is a word with a precise meaning, and cannot be played with to suit convenience. At this rate one could assume a logic of anything one liked. If I had to use Bergson's argument I should have said " process "—a word that can be made to mean anything.

I have spent a little time on this example because it is one of Bergson's own. There are others, but I will only quote one more of them. He poses an example of a man running along the street and falling, causing laughter in the spectators. This is an expression of " rigidity " because it is involuntary. But, continues Bergson, " the passers-by would not laugh at him, I imagine, could they suppose that the whim had suddenly seized him to sit on the ground ". I do not know how these things happen in France, but if my own experience goes for anything, there would be a great deal more laughter forthcoming if a man suddenly sat down in the middle of the Strand, than if he just happened to trip and fall. But, maybe, this is our absurd English delight in foolery. We do not laugh at logic, of any kind.

It seems a very strange thing to me that nobody appears to have observed that Bergson's conception of the comic is all of a piece with his well-known system of metaphysics; and that, like all metaphysical appendages, it is very open to suspicion on that account.

This attitude of suspicion deepens when one studies Bergson's theory closely. The first assertion one comes upon is that laughter is devoid of feeling. A great deal depends, here, on what " feeling " means. What Bergson says exactly is, " l'insensibilité qui accompagne d'ordinaire le rire ". The translator rendered " l'insensibilité ", as " absence of feeling ". But both " sensibilité " and " feeling " are ambiguous words. They may mean sensitiveness and sympathy; they may also, in the more exact sense, stand for a certain mental quality, a quality that is quite distinct from thought, or volition.

Bergson uses feeling in the second sense; feeling means an emotional state. When he says laughter is devoid of feeling, he does not necessarily mean what many people believe he means, that it is unsympathetic. He means literally, that no feeling exists in the mind when you laugh at a very young man smoking a very large pipe, or at Mr. Beerbohm's caricature of the adoration of St. Bernard.

Bergson realises that comic laughter cannot exist in the presence of any degree of emotion (except, of course, amusement); " le rire n'a pas de plus grand ennemi que l'émotion ". This is an obvious truth. But Bergson immediately

deduces from this that therefore laughter cannot exist with any emotion whatever. This is how he describes laughter at the comic. In addition to his reference to " l'insensibilité ", he says, " Le comique exige donc enfin, pour produire tout son effet, quelque chose comme une anesthésie momentanée du coeur. Il s'adresse à l'intelligence pure ". Later he refers again to the comic " faisant taire leur sensibilité et exerçant leur seule intelligence ".

It appears that Bergson, in his attempt to allot laughter a subordinate place in his system of philosophy, has fallen at the start into a grave psychological error. He apparently divides the mind into two distinct sections, intelligence and feeling; and on this assumption feels himself justified in saying " calling into play their intelligence alone."

There are a good many people, besides myself, who will deny strenuously that the amusement they experience when they laugh is not a feeling. But, quite apart from this, the assertion that anything (let alone the comic), appeals to pure intelligence is simply untrue and meaningless. Such a sharp division of the mind into sections is absolutely opposed to both common experience and scientific psychology. Feeling is ever present in any mental situation. I should not be working out a theory of the comic, unless doing so gave me a feeling of pleasure. The most extreme intellectual activity has a basis of feeling in the mind of the man who is engaged in it. It does not need much skill in introspection to realise this. But, because the emotion is not a flaming, obvious one, or one that provokes bodily expression, many people who have never thought about the matter, or who are trying to prove a theory which has very narrow limits, deny the presence of any feeling whatever.

The mind is a whole. Feeling and thought are different aspects of this mind, which is the man himself. They vary in their intensity with different occasions; but both are always present in a specific mental situation. The most emotional state must have its perceptual and cognitive elements; the most intellectual, its side of feeling.

But we can see why M. Bergson wishes us to believe that we are amused with our intelligence, and appreciate Harold Lloyd's cannonading adventures in Mexico with the same intellectual intentness that we bring to bear on Mr. Russell's criticism of Causality. The reason becomes clear when, a page or two later, we come upon the first reference to " mechanical inelasticity "; that is to say, we realise the reason if we know something about Bergson's philosophy.

I do not wish to overweight these pages with any unnecessary philosophical description. But it will, I think, be of interest if I give a very brief sketch of Bergson's philosophy of change; and then show how it is linked up with his study of the comic.

M. Bergson conceives of two great divisions of Nature, Instinct and Intelligence. Instinct (or Intuition) is the essence of life, the élan vital, the flow of life, the stream of consciousness,—everything, in fact, that is Change. Intelligence is the absolute antithesis to Instinct, and can never give us complete knowledge of truth, because it can only see Reality in fragments, by the "cinematographic method"; it can give "no more than a symbolic verity".

Bergson, indeed, looks upon "intellect as a special function of the mind, essentially turned towards inert matter". And, more significantly for our present comparison, is the principle he explains, of the progressive adaptation of intellect to matter. Intelligence is of practical use only, "since it consists in making the general character of knowledge form itself on that of action". "The cinematographic character of our knowledge of things is due to the kaleidoscopic character of our adaptation to them".

Instinct and Intelligence are, in short, two entirely different and opposed spheres of being. Instinct is the stream of life, the Change of his philosophy; Intelligence being a purely practical method by which the individual preserves his existence through adapting himself to his environment in a multiplicity of ways.

Now, it must be clearly understood that the assumptions from which Bergson starts have no psychological basis at all. Intelligence, and Reason are, as comparative psychology has clearly shown, qualities of the mind that have evolved. The instinctive is of the type of mind that does not need to learn from experience, e.g. a moorhen can swim as soon as it emerges from the egg. Perfect instances of instinctive behaviour are evidenced in such insects as bees and ants.

Intelligence implies experience, needs a previous acquaintance to work upon. For it is an alteration of mental and bodily activity, that involves the experiencing of pleasure or pain in connection with an action performed instinctively, and the subsequent repetition or omission of that action, and seeking or avoidance of the object that provoked it. For example, a chicken will peck at anything just after it has come out of its shell, but will alter its behaviour subsequently in accordance with the pleasure or pain it experiences in the taste of the various objects.

A similar alteration in behaviour and thought will occur in a small boy who has instinctively responded to the irritating stimulus

of a bigger boy's taunts, by punching his nose and suffering the consequences. His subsequent behaviour towards the big boy, and big boys in general, will be intelligent. He will have learnt by experience.

I have digressed somewhat in order to show that Bergson's conceptions are scientifically unpsychological, and do not result from empirical observation and experience; and that when he talks about laughter being the expression of intelligence, as distinct from instinct, he is not talking about the intelligence of general psychological discussion. What Bergson means by these terms is not the point. They are not scientific.

The nonsensicality of the axiom that we laugh with our intelligences therefore disappears when we realise that Bergson's "intelligence" is not what we commonly mean by the word. But if "intelligence" is not used in a psychological sense, is not concerned with the investigation of mental experience in the individual, what exactly is the use of bringing it in at all? Surely an investigation of laughter must be based on experience, must be empirical and scientific, if it is to have any value?

The answer to this question is that there *is* a reason in Bergson's stating that we laugh with our intelligence, and that laughter is devoid of all feeling,—which to anybody who has given a moment's thought to the rich feeling element in his laughing enjoyment of Charlie Chaplin's adventures as a gold prospector, seems a surprisingly silly thing to say.

These apparently idiotic and unnecessary axioms are laid down because they bring Bergson's theory of laughter into perfect harmony with Bergson's general philosophy, and system of the universe. I will try to relate the two together.

According to Bergson, laughter comes from the Intelligence. Intelligence in his general theory is essentially bound up with action and "inert matter". Intelligence must be linked up with Intelligence, and cannot, by the very necessity of its nature, ever come into contact with Instinct, which is the way to Reality. Intelligence is the antithesis to Instinct, which is life, the ever-changing flow of one's mental existence, etc.

The rigidity, the "something mechanical encrusted on the living", the absentmindedness, the inelasticity and stiffness which Bergson postulates as the comic, cannot, obviously, affect or partake of the nature of Instinct, which is life itself. Hence the comic must be of the nature of Intelligence. Intelligence in the form of the comic demands Intelligence to respond to it. Laughter, which actually does respond to the comic, is, therefore, necessarily bound to be an expression of this Intelligence. If

it were not, it would contradict Bergson's root principles. But it is. Bergson has made it so.

Here, in short, we have an excellent example of the possible dangers of system-making in philosophy. The whole essence of Bergson's theory of laughter lies in the quite arbitrary assertion that laughter comes from the intelligence. Bergson's theory of laughter hangs on Bergson's system of philosophy. This dependence accounts for its absurdities. And those who decline to believe that their laughter is entirely intellectual, and who experience frequently a very rich and thorough amusement that is perpetually confirming their belief in laughter's complement of feeling, will be disinclined to believe in an hypothesis that involves the assumption that laughter is "devoid of feeling".

One would certainly reject M. Bergson's theory of the comic if any other theory that covered all the facts were forthcoming. One would, in fact, reject it if facts appeared that rendered it doubtful. For there are strong grounds for thinking that the Bergsonian conception of laughter and the comic has been created with an eye focussed continually on the larger Bergsonian conception of life and the universe, with which it must agree on a priori grounds.

I have already called attention to a couple of doubtful interpretations in M. Bergson's essay. Outside, in the actual life of laughter, there are other instances that are either impossible to harmonise with Bergson's hypothesis, or that can only be squeezed under its all embracing cloak by involved manoeuvring.

It is not necessary to go to the effort of tabulating a list of examples. They are everywhere, if one only had the eyes to see them. Why should I laugh at the memory of my acting as a temporary docker? Why should so many people find modern French painting so extraordinarily comic? Why, for instance, should "Beachcomber", normally a man of some culture, find the delightful Douanier Rousseau funny? Art is the very antithesis of the rigidity imposed on life that is for Bergson the comic. Why should one man find something "rigid", that another man finds the very essence of the flow of life? Clearly they differ because their nature, experience and ideas differ; because they have different conceptions of "rigidity".

In the first place, therefore, we must do away with the idea of "rigidity" as being a universal concept. We do not laugh at the imposition of the "rigid" on the flow of life; we laugh at what we ourselves conceive to be "rigid". Our perception of the comic is essentially personal. There is no general formula for the comic; because the comic is what we think is comic. Every man has his own conventions, his own ideas of what should, and

what should not be done. I may think something laughable and absurd, that you consider eminently sane and reasonable. Just as you may laugh at something in which I cannot find a spark of comedy.

Englishmen find a wealth of humour in the French habit of embracing in public; but this perfectly natural expression of sentiment is not allied to "rigidity"; and we do not laugh at it on this account. We laugh because it is absurd, funny, is not as we do ourselves.

It is not, then, in response to a generalized object, "the comic", that we laugh. We laugh because something occurs that we, often we only, find comic. The individual, in fact, must be taken into account. But, not only is the individual the core of laughter on the comic side; there is besides the side of feeling and emotion, which is equally important, and which may put an embargo on the most farcical occasion.

The existence of this relation, "the comic", in Nature is only a part of comic laughter. The man who laughs must be ready to laugh. This relation, which Bergson calls "rigidity" depends, therefore, on both the experience and nature of the laugher. It is, in fact, a much more complicated and personal affair than Bergson would have us believe. The "rigid" must be so, only in relation to one's individuality. It varies with each one of us—often radically, sometimes absolutely; and its character is always relative.

But, now that we have come so far from Bergson's conception of the comic, and have discovered in it so much that is either misleading or incorrect, is there any necessity to retain any of his ideas at all? Can we explain the comic on a simpler basis than Bergson—on a basis that does not involve any metaphysical assumptions, or deceptive literary symbolism, and that has an altogether more economical, and hence more easily acceptable basis?

We have shown that Bergson's postulate of "intelligence" being the source of laughter in ourselves, is a pure fiction, and only posited to meet other metaphysical requirements. "Rigidity", too, is not an impersonal or general conception, but is bound up with the individual's experience, and his temperament and feelings.

Examples occur frequently in life that are either impossible to explain by Bergson's theory, or only explainable by the use of very elaborate and indirect argument. Bergson's own examples are largely one-sided. Mr. Edwin Muir has said, in criticism of a rather comical statement that "Molière is a Bergsonian because his comedy fulfils the requirements laid down by M. Bergson in his little book": that "the truth is, M. Bergson's conception

of comedy is a French one; . . . . it does not justify Molière's comedy (which is only one among the chief kinds of comedy) but derives from it". I do not know whether I should go quite so far as this; but I certainly agree that Bergson would not have given us his mechanical theory of laughter had he been an Englishman.

I have discovered by personal experience that one can always find "rigidity" present in any situation whatever, whether comic or otherwise, that one cares to imagine. It is a very elastic concept, because it is a metaphysical term without any precise meaning. It has not the immediate, definitive, meaning of a common, "practical" word, such as hand, or hat, or home. Why do we not laugh, for instance, at a dead stick floating in a stream? This is a perfect example of "rigidity", brought out clearly by the direct contrast of Change, in the flow of the stream.

You laugh at a man riding on a motor-skacycle. This is funny Bergson would say, obviously because it is an example of "rigidity". But you also laugh at a camel walking through the streets. Or at the idea of a Duke, fitly apparisoned, walking down Piccadilly, and eating a banana. Or of a naked man in a public place. Bergson has no such examples as these and a dozen others one could enumerate of something entirely natural and flexible (as opposed to rigid) causing laughter. If pressed, the only explanation he could put forward would be that you laugh because the "rigidity" of society is revealed by the comparison—although he states himself that "as we are both in and of society, we cannot help treating it as a living being"; and although he regularly hypostasies society as the judge of what is comic, "Society will therefore be suspicious of all inelasticity"; "It is rigidity that society eyes with suspicion" etc., etc.: and although he implies that life and society are of a kind, if not actually identical. For instance; "Now, such a notion (of disguise) is formed when we perceive anything inert or stereotyped, or simply ready made, on the surface of living society. There we have rigidity over again, clashing with the inner suppleness of life".

These, and many other instances of the comic, can only be accounted for by Bergson by a denial of his initial assumptions. But is it possible to formulate any other theory of the comic, that will both cover all the facts, and act as a clear and sufficient explanation? I think that it is possible to do so.

One of the oldest theories of the comic is that of incongruity. At first sight this theory seems a good one. But, when one begins to investigate a little, many instances crop up that are manifestly incongruous (and hence, on this argument, perfect examples of

the comic), but which are, unfortunately, incongruous with the theory of incongruity, and have no association at all with laughter. Six fingers instead of five; a two-headed monster; deformities of any sort; infant prodigies; spilling ink; eating peas with a knife (if you are associated with the eater); dropping aitches (with the same proviso); falling down (if it is yourself);—all these are incongruities. But many of them are disgusting; or repellent; or arouse curiosity; or irritation, or acute discomfort, and shame; or inflict pain of some kind. Spencer, in his essay, gives a half page of incongruities that are not comic.

Incongruities being, as often as not, in no way comic, the comic element that is found in many of them must, it appears, be sought elsewhere, not in the incongruity itself. For incongruity to be a true and inclusive explanation of the comic, it must be shown clearly that it is incongruity alone that causes laughter; and that incongruity is invariably a source of amusement. But neither of these conclusions agrees with actual experience. The latter I have just shown to be untrue. The former is also insufficient, inasmuch as the incongruous alone does not account for every example of the comic. For instance, the element of surprise, which is a most important source of comic laughter, cannot be explained by a theory which makes incongruity its sole basis.

There are, then, two objections to the theory of incongruity as it is popularly held—the first being the most important. Many incongruous things are not comic; and some things are comic that do not come under the head of incongruity. Such an emphatic denial of the truth of the theory of the comic as incongruity would seem to put it completely out of court, and render it a wholly useless concept.

But, in spite of its crudity and inconsistency, there is a certain amount of truth in this theory. By accepting this core of truth and rejecting the rest; by bringing what is true into new relations; and by an insistence on the intimate association of the object perceived and the nature of the observer, I think that I can point the way to an inclusive and satisfactory solution of the comic.

The argument of incongruity has never recognised the psychological and individual side of the question at all. The thing is incongruous, and that is enough. The casual observer immediately points out several incongruities that do not arouse laughter; and the theory is useless.

An incongruous thing, as I have already pointed out, can arouse many different feelings in a man besides laughter. It may have a variety of meanings, pleasant and unpleasant, and some of them very far from funny.

The essence of this statement is the meaning of meaning. What is the relation of a thing to a meaning? We must distinguish the difference between a thing in itself, and the meanings of that thing. I cannot go here into the problem of knowledge; it will be sufficient to accept this thing in itself "under acknowledgement", just as we do in the affairs of everyday life. One may say that a thing cannot be distinguished from its properties; it is obvious, indeed, that a red rose means, to a man who is partly colour-blind something different from what it means to me. The difference, at any rate, is sufficiently great for one to be able to say with truth that he could not see the humour of a man wearing a red top hat at a wedding.

But, generally speaking, things have much the same properties for all of us; and it is only rarely that a difference of property gives a difference in meaning. It is in the meaning of things that the difference lies; and that difference is sometimes enormous. For instance, a carving knife has a meaning for me that is entirely different from the meaning it would convey to the relative of a man who had just been murdered with a carving-knife. And the same tadpole has a meaning for the biologist that is vastly different from its meaning to a small boy. A poppy in a field of corn meant a very different thing to W. H. Hudson, and to the farmer whom Hudson enraged by praising its beauty.

The meaning of an incongruous thing, like the meaning of an ordinary thing, may vary very considerably. Its meaning depends entirely on the person who perceives it. A thing is only ugly, or disgusting, or curious, or painful, or irritating, or embarrassing, or funny,—to a person. A man without a sense of shame would not mind awkward situations in the least; and yet there are people who would not go out of doors on Sunday in a cap. Whether you find incongruities painful, or negative, or pleasurable depends entirely on yourself. The possibility of humour in an incongruity lies in the person who perceives it. An incongruity cannot contain a comic meaning if it already possesses any other meaning that is strongly coloured, and intense.

It should always be realised by those interested in the comic, that comic laughter can never co-exist with any other emotion or feeling that has the elements of displeasure or pain; nor with any really positive emotion, such as interest of any kind. There must be a substratum of comfort, and the absence of an emotion of any degree of strength.

We have now arrived at the conclusion that an incongruity can only be comical when the mind is in a certain state of passivity, and is not likely to be disturbed by the incongruous introduction.

But incongruities do not explain all by a very long way. There is, indeed, no such thing as incongruity, any more than there is an impersonal abstraction we can label " the comic ". There are only things that seem incongruous to individuals, or that are comic for you or me. We use these generalising terms for convenience' sake. It is simpler and less pedantic to talk about " the comic " than " what people think is comic ". But this usage has its dangers.

Words imply by their very being some definite fact or object to which they stand in relation ; and,—so vicious and so prevalent is the tendency to dramatise,—that " abstract " words are very much inclined to be given an individual, artificial, pseudo-existence of their own. This applies far wider than the little problem of the comic on which I am at present engaged. The giving of a name to a process, or series of events, or group of facts, and then hypostasizing it as an entity on its own, has vitiated much modern philosophy. Biologists with philosophical interests are having a very difficult time in pointing out that evolution, life, progress, vital force, instinct, and other descriptive terms for processes, or bundles of facts, are not " explanations ". But their efforts are far too often without effect. And the philosopher, deceived by a name, himself tries to deceive again by flinging some term of abuse, such as " mechanist ", or " materialist " in reply.

But to return from a digression that is itself tending towards incongruity. Incongruity only means, incongruous to certain individuals. Also, not all things are incongruous that are comic. And, finally and most important, not all incongruities with the possibility of comedy in them, are actually found comic by everyone.

I propose, therefore, to drop the word incongruity,—which tends to be hypostasized ; and to substitute in its place an axiom that has all the virtues of the theory of incongruity ; that avoids, I think, all of its faults ; and that accounts for the important and hitherto neglected correlation of a readiness to laugh at funny things, with the presence of a merry mind. It takes into account, also, the individual you and me, who are, after all, the people who laugh, and with whom a theory of the comic should be concerned.

" When an object, or occasion, appears on a person's mental horizon, that is different from that person's beliefs, and experience ; and providing it arouses no specific interest or emotion, and occurs in a normally pleasurable mood. Then that object, or occasion, is, or tends to appear, comic to that person, granting that his usual ' pleasure-level ' is of a normal height ".

This sentence contains all the essentials. Its covering clauses may remind you of a conveyance. But they embody factors

that have been omitted from previous theories of the comic, and that are absolutely necessary for any explanation pretending to be complete.

The idea of the comic varies from man to man, irrespective of the difference in men's natures that I take into account a few pages later, and which are equally important. It varies still more from age to age; and varies almost fundamentally from country to country—as anyone who ever reads the "Review of Reviews" knows very well.

This variability means that the comic differs from mind to mind; that the mental content of one man differs from that of another man who is in the same situation and is looking at the same thing —when one is laughing, and the other is not. And this implies that the idea of the comic in every man is absolutely connected with his entire mental make-up—his nature as well as his experience. This relativity of the comic does away with the idea of there being any such specific object in Nature to prompt comic laughter as many philosophers will have you believe. Laughter is not an instinctive activity reacting to a specific stimulus. It is instinctive, but it is generalised, and will not wear any tight glove of "rigidity" or the like.

Whether you see a thing as comic depends on you, not on some mysterious quality possessed by the object of your laughter. I have known men sit glum and silent through a Chaplin film, never flinching an inch. I have, indeed, spoken to one who could not see anything funny in Chaplin at all. This, I grant you, is a very rare phenomenon. Chaplin may be scorned, in snobbish ignorance, for what an eighteenth century critic would have called his "lowness" (Goldsmith was "low"). But he is always recognised as being at least funny. This person, however, was not a humourless man. He had a sense of humour; but it was "queer".

Here, clearly, is an extreme case of difference in mind. I have given other examples before; and there is no need to add to the list. For it is pretty generally realised that what is one man's comic meat is another's poison.

We have now come a long way from such restricted concepts as "descending incongruity", or "rigidity". We are, indeed, approaching the first, and most interesting, part of my explanation of comic laughter.

There is, to the close observer, one element common to all examples of the comic; something that is true of every instance in my and your experience—and that is the quality of difference. The comic is always something different. Different from what you are used to; different from what you expect; different from what you think

correct, right, and natural; different from the usual, normal, and ordinary; different from what you think ought to be.

For instance, a hole in the seat of somebody's trousers (other than your own) is funny. But, then, so is a large patch; and the patch may be white, blue, green, red, or orange; may be checked, or striped. The larger the patch, the brighter the colour, and the more extraordinary the design, and the more respectable the wearer, the greater will be the comic effect. The humour would not be understood so well by someone who was not well acquainted with European dress, say a Hottentot—simply because the difference would not be perceived.

A fat old lady, of some fashionable pretensions, with an Eton crop, is a most amusing sight. But she would be equally comic if she wore her hair long, trailing in waves over her shoulders; or in girlish curls, as a person living in my neighbourhood wears her hair; or if her hair were brick red; or if it were enclosed tightly in a large, round, caul that made her look as though she were wearing a flat cushion on top of her head—after the fashion of a woman who recently served me in a country tea-shop. All these different and opposite ways of dressing hair are comic; and no specific principle can account for all of them. The real reason why I think them funny is that they are different from the usual English style of wearing hair—the style I am used to.

Again, I am playing with a new gadget for lighting the gas without using a match. I place it against the jet, and turn on the gas, which lights up immediately: and, as I see the flame spring to life—I laugh. This is laughter at its simplest and most naïve. I know very well that the thing is meant to light the gas. I am really expecting something to happen. Nevertheless, I cannot get beyond a certain primitive incredulity. For some reason I cannot make myself believe that so mechanical-looking a device can light gas without some sort of friction. And, when practical proof appears, I am surprised in spite of myself and laugh. If I were in a hurry, or if the gas went off with a bang—I should not have laughed. The mental conditions would not have allowed. But, as the situation was a normal one, I could laugh freely,—as I did. And I laughed because something had occurred that I had hardly expected; something different from my primitive beliefs.

I could multiply these examples, but it is not necessary. The element of difference is obvious directly one begins to make enquiry. An indirect confirmation of my argument lies in the usage of the words, funny and absurd. In common parlance, these words stand for much more than the comic and amusement. "Funny" is not only comical. It means anything extraordinary, unusual,

not to be expected,—anything "queer": and is used, perhaps, more commonly in this, than in its more exact sense.

"That's funny!" "a funny sort of fellow", "a very funny affair",—this may be a very lazy and slipshod usage, but it is very widespread; and, what is more important here, the alternative meaning of the word has a significance. Colloqualisms may be deplored; but they usually have some practical value. Common, everyday, language is often loose and inexact. It is, in fact, probably this looseness that lies at the root of much philosophical argument. For not all philosophers define their terms exactly; and exact definition is absolutely necessary, when such words as vital, mechanical, pleasure, pain, jealousy, evolution, are used in such a variety of senses. In common language we still talk about the sun setting, though we all realise that the earth travels round the sun. For practical purposes it is quite sufficient. It makes no difference to us when we have to switch on the light in the evening. The phrase is not exact, but it is exact enough for everyday.

Popular language has practical value. And, when the same word is used in two different senses, there is bound to be something in common. "Funny", may mean either comic, or unusual. Shaw uses the word in its two different meanings within fifty words. Mrs. George (in "Getting Married"), says: "I'm a very funny woman I daresay". And the Bishop comforts her by replying, "Quite so: but then, I'm a very funny Bishop. Since we are both funny people, let us not forget that humour is a divine attribute".

Shaw changes suddenly from one meaning to the other; and it seems quite a natural thing to do. He makes "funny" mean both queer and comic. What is at the root of this double usage? What is there in common here? Clearly it is the element of difference that the one points out unconsciously in the other; and that confirms indirectly the theory of the comic I have outlined in these pages.

I have now dealt very fully with the first part of my axiom, and shown, I hope, that a man's idea of the comic is personal on the side of perception. This, however, is but a part of the story. I now intend to complete it by reference to the second and third, and especially the third.

A basic factor for the appearance of comic laughter is the existence of a comfortably pleasant state of mind unoccupied by deep interest or emotion. Laughter, of course, occurs in many moods. It may break a fit of the blues, or shatter a splendid argument. But it is much more likely to occur when the mind is unoccupied.

Also, laughter will only occur very exceptionally if you yourself are immediately involved in the comic situation; and it will not occur at all if the object laughed at arouses your active interest in any way, either unpleasantly, or specifically thrilling.

If you are passionately in a philosophical discourse, you would not be nearly so inclined to laugh at the lecturer's habit of twitching his ears, as would a person who was not so keenly attentive. Nor would you laugh if you had a ramping headache, or were facing the prospect of financial ruin.

The comic is always looked for eagerly by those who love the pleasures of laughter; and it may be found in the most unlikely places. Man has found laughter, and the lively emotion of amusement that goes with full comedy, to be such a happy experience that he seizes on the slightest opportunity of enjoying it. But comedy occurs far more easily at some times than at others, and where the situation arouses active attention it will not arise at all. Even Mr. Leacock would not laugh if he felt his braces bursting while he was giving a lecture to a Mayfair audience. He would laugh afterwards. But his feelings would be far too agonisingly active to allow laughter at the time.

I conceive that the last clause of my axiom, which concerns itself with the nature of the man, is of equal importance with the clause that deals with the perceptual, " thinking " element. I find it rather difficult to describe the mental attribute which controls comic laughter from this side; but I think that " pleasure-level " is a sufficiently clear analogy.

It is not enough by a long way to explain the comic in perceptual terms. The feeling of jollity and exuberant pleasure is absolutely connected with one's experiencing the comic. I lay particular emphasis on the personal nature of comic laughter, and its entire dependence on the man himself. But this does not only exist in the *experience* of the individual—on the " thinking ", cognitive side of his mind. It holds, as well, with his nature, his temperament, the general level and intensity of his feelings; his joy in living; his bounding mental energy; his rich supply of pleasurable élan.

The comic is created by the individual man—actually created. It is a product of his own mind referred to certain objects and occasions in Nature, partly under the stress of the vague indeterminate feeling that anything different evokes in one's mind; partly under the creative touch of a man's jollity, an overflow of " instinctive happiness " into certain things and events; and partly under the influence of the unconscious magnetism that lies in the pleasure of laughing—" an excuse for the laugh ".

For instance, if A who is of a naturally glum and morose nature, does not laugh at something that amuses B, who is a merry fellow, highly; we all say that A cannot see the humour in the situation. This is a general usage, and it would be very pedantic to jib at it. But it is not really true. Although we all repeat it, it is actually an inaccurate and careless phrasing; for it implies that there is actually something, out there in Nature, which A overlooks. And, even if it is said that the thing *appears* funny to the one, while it does not to the other, I still hold that the statement is incorrect. "Appearance" of the comic to one and not to the other implies that there was something actually, objectively, comic, something whose "appearance" was granted to B, but not to A.

The real truth of the situation is that B made something, and that A did not. B, under the influence of his merry nature lighted on something that was different from the usual run of his experience. Laughter comes easily to him at all times; and the undirected, indefinite, feeling, prompted by the sight of this thing, combined with his easy laughter, and with the appeal that the act of laughing has for him, all go together to make him find it comical and laugh at it.

A, the depressing fellow, may also have seen the occasion as different from his usual experience; but, not having the rich exuberance of feeling that results from a merry nature, and not finding the joy in laughing that B does, the thing is not comic for him and he does not laugh. The incongruity may be actually the same for both of them; every condition may be present to allow laughter. But it is not seized upon hungrily by A. It is passed over, and neglected. It is not, however, the comic that is missed; the thing has to be gathered to the laugher's bosom before it becomes comic.

Before a "difference" can become a piece of comedy, the individual nature of the observer must grant its permission. A person may not find a certain thing comic for other reasons than melancholy, glumness, coldness, and the like. He may be a snob. He may think laughing overmuch to be vulgar, and his overmuch may be your overlittle. He may consider it low to laugh wildly at Harold Lloyd trying to manage his five drunks on top of the bus, in "For Heaven's Sake". And, though the "differences" may be most obvious ones, and shared by all alike, they will not be comic for him. But, in laughing ourselves, we are not getting a glimpse of an objective something which he is not; although, of course, we are experiencing a subjective something which he is not. We are both perceiving a "difference", but it is not a comical object. It is only comic for the man who is amused by it. And his amusement appears because he has a jolly, joyful, nature.

If a person dislikes laughing for any reason—on account of puritanical piety, or fancied dignity, or mere distaste,—an example of difference will only make him laugh under the most pressing of circumstances. If he likes laughing, but is not of a particularly merry turn of mind, he will laugh and be amused much more easily. But, if he is a really jolly fellow, he will laugh freely and often at every difference that circumstances allow him; he will, indeed, in all probability, make laughter out of objects,—such as Mr. Churchill's hats,—whose comical quality was killed long ago by repetition.

The comic is infinitesimal for the first. It is frequent for the second. But it is everywhere for the last, whose mind is truly a creative one. In the last two laughers the actual "feeling" that the example of difference produces in itself alone, will mingle very easily with the natural "pleasure content" of their minds; and hence will easily produce the amusement whose expression is laughter. This feeling, which in a laughterless man may be thin and impoverished, will be greatly enrichened by fusing with the exuberance of instinctive happiness in a merry man.

The comic is not the pleasurable, as has been held by some. But neither is it to be explained in terms of cognition. It is a combination, in varying degree, of an overflowing of diffused pleasurable feeling, which is present in most men, but which is especially characteristic of the jolly man; and the occurrence in Nature of certain events and occasions that differ from one's beliefs and usual experience. The comic is created partly by the merry mind of the laughing man, partly by his observation and experience. An incongruity may, on previous theories, be absolutely ideal for comic laughter. But it may, all the same not be comic. That depends on the nature (as apart from the experience), of the individual laugher.

The point to be realised is that there can be no line drawn between what is comic and what is not comic; not even with the same man. For what one finds funny at one time, may not seem funny at all at another, although the conditions seem perfect. The comic simply cannot be understood by attending to the thinking side of man alone. This has nearly always been the method of approach. I consider it fundamentally wrong, and misleading. You cannot pick the comic out of Nature, as Jack Horner picked the plums out of his pie. If it is a plum it is an indeterminate and changeable one, growing in unnatural fashion, now small, now large, now entirely vanished. If you must make an object of it, it is a Chestertonian one, with the queerest and most fantastic habits. The comic is, indeed, very much a Chestertonian conception if it is divorced

from the mind of the individual. But, if it is realised that it is of the very texture of one's own mind, an expression of self, as intensely personal as one's ego, the paradox melts into nothingness.

The comic cannot be treated in vacuo. It has to be treated in people. The individual case demands individual treatment, in this more than in most things. The man as a whole must be considered, and oversimplification must be avoided like the plague. "Sense of Humour" is really a very vicious and harmful phrase, is yet another example of the invariable tendency of mankind to make things appear so very much simpler than they are.

I recently came across a rather good illustration of the argument I am propounding, in Prof. S. Alexander's lecture "Art and the material". Prof. Alexander believes that the work of art results from the passionate mood alone.

"I suggest that the artist's work proceeds not from a finished imaginative experience to which the work of art corresponds, but from passionate excitement about the subject matter. . . . Excitement caused and detained by this subject, and at once enlarged, enlightened, and inflamed by insights into it, bubbles over into words, or the movements of the brush or burin or chisel".

Prof. Alexander then applies this to humour in a most interesting and valuable way.

"Anyone who happens to be blessed, or cursed, with the gift of humour—I mean, of course, spontaneous humour as distinct from the odious habit of premeditated jocosity—and practises it to some degree as a fine art may test his own procedure. A person or topic releases within him a hidden spring of gaiety, flavoured perhaps with a slight submalicious ingredient, and the spring issues forth into jest. It is his gaiety which produces the words, and no image of what he means to say. Hence it is that the jester so rarely laughs at his own jest. His laughter has preceded the jest and has been done with; for him it is part of the cause of the jest, and not, as for his hearers, the effect".

It is the excitement, or passion, "the gaiety", of the mood that creates the jest. An absolute antithesis holds between "premeditated jocosity", and spontaneous jesting. In the one there *is* an image, calculated,—perhaps with the aid of manuals on how to be funny—to a painfully thorough degree before being made public. In the other the jest springs, fully armed, from the ocean of one's mind, created somehow and somewhere, in a way of which we have not the vaguest inkling, but which we accept with natural piety. It is spontaneous and natural, and is, of course, an absolutely individual affair.

What Prof. Alexander has said of the art of making a joke, I

wish to say of the recognition of, and laughter at, the comic, which is, I hold, an essentially similar process,—implicit where jesting is explicit. Perception of comedy arises spontaneously from the jolly mood, and is largely caused by it. The jester only goes a little way beyond the laugher. He consciously creates a comic situation to provoke laughter, and the joy of amusement. The other unconsciously creates it.

THE ANTILOGISM

By CHRISTINE LADD-FRANKLIN

In the brief note which I sent to *Science* a few months ago in which I first published the logic-poem which Mr. C. K. Ogden was so good as to reproduce in *The Forum*, I did not take time to point out all the curious logical features that are concealed in it. I repeat the poem here:

Unless the kettle boiling be
They labour in vain who make the tea ;
Unless the tea be properly made
My guest will not like it I'm afraid ;
Unless my guest contented be
She'll never again come visiting me.

Consequently :

Unless the kettle boiling be
She'll never again come visiting me.

In the first place it is what I have proposed to call a " continued syllogism ". Common Logic has been so ill-advised as to preserve the uncouth scholastic name " sorites " for this. But (2) it is moreover a *compound* continued syllogism—what Common Logic (I use this term, following Alfred Sidgwick, in the derogatory sense) has not yet turned her attention to, although she has been at her long task for two thousand years or more. It is, moreover (3) a form of reasoning which, though it looks to the plain man as if it was perfectly legitimate, is absolutely incompatible with the most fundamental law of logic. This law says states that the term common to two premises (what logic calls the " middle " term, doubtless on the *lucus a non lucendo* plan, for it occurs, as they arrange it, not in the middle but at the *two extremes* of the major and minor premises) must be exactly alike in both of them. The opposite is the case in my typical logic-poem,—the common term (in this case a common proposition, but the situation is exactly the same in the simple form) is once positive and once negative. This will be plainer if we drop the rhetoric that goes with rhyming and reduce the poem to bare prose. It will become :

Unless the kettle is boiling, the tea will *not* be good ;
Unless the tea *is* good, my guest will *not* like it ;
Unless she *does* like it, she will *not* come again ;

Consequently (uniting the first and the last subsiderary propositions),

Unless the kettle is boiling my guest will not come again.

It will be seen that the " common term " is in every two adjacent lines as far as possible from being the same thing: we have (ignoring, as logic must, differences in tense) " she does like it," " she does not like it ; " " the tea is good," " the tea is not good," etc.,—one might go on as far as one liked. This is really shocking to Logic, according to its universal rules. And yet to the general reader this poem looks like good reasoning—and not at all difficult. I have tried it out on many people and none have ever found any difficulty with it. I tried it one morning on my good stout coloured cook from Virginia. I first explained to her that I was about to read her something as a sort of a joke, and then to ask her whether she found it to be good reasoning or not. When I had finished, she said at once, being a good faithful serving maid, intent upon her duties, and having forgotten for the moment my preliminary explanation: " Did you say you were going to have some people in for tea this afternoon ? " But when I had explained the matter to her once more, and read her the poem again, she grasped the situation at once, and affirmed that the reasoning was sound. Certainly any normal, naturally intelligent, human being would do the same thing.

But suppose now we transform this continued syllogism into one in terms of " not unless ". We shall have: " Not unless the kettle is boiling will the tea be good ; not unless the tea is good will my guest like it ; not unless she likes it will she ever come again. *Hence*, not unless the kettle is boiling will my guest ever come again ". But what have we here ? This syllogism seems, like the other, to have perfect validity, and yet its " common terms " will be found to be, each pair of them, of the *same* sign, *both positive* ! But is it conceivable that this compound continued syllogism will obey the logician's rules if you begin it with " not unless " and will run directly counter to them if you begin it with " unless " ? What sort of a topsy-turvy world is this ? It is surely a world in which one needs assistance of some kind in order to keep one's head in reasoning.

Or : Let us take, again, an example of a syllogism in " *simple* " terms in the form in which our first difficulty arose (the term common to both premises being once positive and once negative)—take this other case (which is also reproduced by Mr. Ogden) the one whose significant words (a good find) begin with the logician's beloved letters, s, m, and p (but I do not find that he has ever for himself constructed a seeming-sensible syllogism of this description) : " If no priests are martyrs and no saints are non-martyrs,

then no saints are priests ", or (what is the same thing in the form of the antilogism) " that no priests are martyrs, that no saints are non-martyrs *and* that there are some saints who are priests *is an impossibility* ". Surely martyrs and non-martyrs are not exactly the same thing, what we have been taught must always be the case in the valid syllogism. And yet this is plainly perfectly legitimate reasoning. What is the matter with Common Logic?

Perhaps I ought to send my readers to the very good, though brief, account of my system of logic given in *Mind* for January, 1927, by my talented friend and student, Dr. Eugene Shen. That system has been devised to take account of such difficulties as I have here brought up, and thousands more of the same kind. It gives a vast extension to common logic. It enables one to deal with (among other things) the countless plain and simple syllogistic (and anti-syllogistic) forms, as well as with the simple conversions that may be met with in real (and in unreal) life. It makes one acquainted with the fact, for instance, that the real number of syllogisms that one must be prepared to test the validity of is 8192, instead of the paltry 15 that Common Logic has learned to handle.[1] It is plain that some symbolic technique—what Mr. Ogden has emphasized the necessity for, when reasoning becomes at all intricate—is very necessary for solving such problems as this. Who can tell whether these two statements are logically, equivalent —do they amount to exactly the same thing or not? " Not unless it rains do I take an umbrella " and " Not unless I do not take an umbrella does it not rain "? And the would-be solver of this question is permitted to do it either by instinct-logic or by any of the rules that he has in his possession. There are many seeming good logicians who cannot do it at all.

Senator Nelson said lately in the U.S.A. Congress: " *It cannot be that* any of these measures are idiotic, for none of them are unnecessary and nothing that is necessary is idiotic ". Senator Nelson (although he did not know it) was here outside the bounds of common Logic. He was actually making use of the antilogism, a kind of reasoning that Common Logic is incapable of dealing with

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[1] This number becomes necessary after one has (1) increased the number of propositions by adding the omitted relations:

all but — none but
not all but — some besides

(with the corresponding English words for the compound relations); (2) has introduced the existence-terms, and (3) the functional terms *and* and *or*. Thus the *a*'s are all *b* requires one to have also under consideration its equivalent forms:

" Things which are at once *a and* non-*b* are non-existent " and " *Everything* is either *a or b* ".

in the form in which it occurs—common logic does not even know that such forms exist. But that the antilogism (the reasoning of rebuttal, of discussion, instead of that of concluding—*Schliessen*) may be a very primitive form I prove by the fact that the following incident actually occurred. A little girl of four was making the interesting experiment of eating her soup with a fork. "Nobody eats soup with a fork, Emily", her mother said to her. "But I do, and I am not nobody" Emily immediately replied. Not only is this argument an Antilogism, but it also contains an existence term—a thing quite unknown to the ordinary logician.

Mr. Nelson showed, when he uttered these famous words, a really beautiful flair for instinct-logic.

CURRENT INTELLIGENCE

The Blunting of Self-Criticism.

It is not often that psychologists can find matter for congratulation in the publications of H.M. Stationery Office, and still more seldom does the Board of Education enter the realm of spirit. That, however, does not justify the neglect of such excursions when they occur, and the recent Reprint of a Syllabus for Teachers on the Hygiene of Food and Drink is certainly worthy of more attention than it has received.

The British Public has spent some £2,600,000,000 ($13,000,000,000) on alcohol, which as the Syllabus points out cannot be drunk pure, because it causes a hot painful feeling in the mouth, throat and stomach, and also produces direct injury. It can only be taken when diluted and made weaker by mixing it with water and other liquids.

Beer, wine and spirits all contain alcohol. There is some in beer, more in most wines, and a great deal in spirits. It is for this reason that although beer will not burn, brandy will, and here we are given the percentage of alcohol by volume in some of the commoner alcoholic beverages may be stated as follows :—

Lager beer contains about 4-5 per cent.
Bottled beer „ „ 5-7 „
Claret, hock, etc, contain about 9-10 per cent.
Port, contains about 17-23 per cent.
*Spirits { Rum / Whisky / Brandy } contain about 40-50 per cent.

Some of the " medicated wines," sold by chemists contain a large percentage of alcohol, and, for this reason, harm may be done by their use as " tonics."

Contrary to popular opinion, says the syllabus, the effect of alcohol on the nervous system is to depress rather than to stimulate its functions. The apparently stimulating action, as shown by the stage of excitement through which the drinker may pass, is due to its depressing action upon the highest and latest developed part of the brain, namely, that which is associated with the exer-

cise of the intellect and of the will. And here the writers paves in to the psychological field, with the remark that the emotions are released from proper control and left free play to respond to the immediate environment in which the drinker finds himself. This as a rule is of a convivial character, and from this point we leave the syllabus to speak for itself.

The emotional characteristics, it recalls, are the oldest established; they have their seat in certain lower parts of the brain which are developed early in the animal scale. Next in order of development come the nerve centres associated with the sensory and skilled motor functions, and latest of all is developed that part of the brain connected with the higher intellectual faculties.

Thus, the action of alcohol is to depress the functions of the brain from above downwards in the reverse of their development in the individual and in the race.

Among the successive steps the following are noted :—

(i) Blunting of self-criticism.—Self-criticism represents the latest developed of the intellectual functions. When it is blunted, actions are indulged in or remarks made which are not consistent with the usual character of the individual. The resulting effects of this blunting are various to an almost unlimited degree; but certain of them are particularly characteristic of the action of alcohol, and emerge with considerable regularity on carefully conducted tests and experiments. Among these may be cited :—

(*a*) uncritical self-satisfaction of the individual with his work and actions;

(*b*) disregard of occurrences and conditions normally requiring caution of act and word;

(*c*) trespass of rules and conventions previously respected;

(*d*) impaired appreciation of the passage of time;

(*e*) talkativeness;

(*f*) an argumentative frame of mind; quarrelsomeness.

(ii) Interference with the performance of skilled movement. This is indicated by clumsiness of behaviour, by the slurring of words.

(iii) The blunting of the senses—of hearing, taste, touch, and vision.

(iv) The display of the primary emotions. Anger may be displayed at one moment, and affection at another; similarly with boisterousness and depression, laughter, and tears.

(v) The failure to respond to external stimulation and the eventual lapse into a heavy sleep.

At each successive stage in the process of "intoxication," it will thus be seen that the action of alcohol is chiefly *narcotic*.

and in conclusion the Syllabus quotes a summary by the Alcohol Committee of the Liquor control board in their review of the existing state of scientific knowledge regarding the action of alcohol on the human organism :—

"A further conclusion of capital importance which emerges with equal clearness is that the action of alcohol on the nervous system is essentially sedative, and—with the possible exception of its direct influence on the respiratory centre—is not truly stimulant. The popular belief in the stimulating properties of alcohol, as regards nervous and other functions, seems to be of purely subjective origin and illusory; it is in the main, if not wholly, an effect of the narcotic influence of the drug, for, as we have seen, it dulls the drinker's perception of unpleasant conditions in himself and his surroundings, and may make him feel better, more efficient and stronger than he really is. Effects which are apparently of a different character—effects such as the increased loquacity and freer gesticulation produced by alcohol—which are usually interpreted by the drinker, if not by those about him, as evidences of stimulation, are really narcotic effects; they result from the removal of the control exercised by the higher nervous centres, a control which enables the individual to weigh his words and acts, and renders himself critical and solicitous as to the impression he is making on other people. The removal of this control and the decrease of critical self-consciousness are, in fact, the most moderate dose which diminishes restraint and imparts courage to the diffident speaker, or in the excessive dose which gives rise to the verbose diffuseness of drunkenness."

CURRENT LITERATURE

Grammarians once quarrelled about split infinitives. We object to the definite article—perhaps as captious as the grammarians—for if Dr. Collins had said *A* Doctor, instead of *The* Doctor,[1] we would admit the autobiographical character of this series of loosely united essays, instead of criticizing the individual dogmatisms and prejudices which mar so many of its pages. Bumptious assertions so often take the place of critical knowledge that we are disposed to place the work alongside much of our tabloid literature instead of affording it the high praise which in many places it really deserves.

Shane Leslie once wrote a fascinating work upon the genius of the Celtic mind; he omitted to call proper attention to its weaknesses. In this work Dr. Collins exemplifies both. It is clever, amusing, entertaining; there are flashes of real wit, and bits of profound acumen and penetrating insight, but for us it is too often spoiled by the flair for parodox and the superficiality of satire. Above all it is irritatingly spotted with assumptions of authority and of learning which spoil it as a bit of literature or of science. He leads us temptingly along the path of truth by easy steps and then unblushingly states an absolutely false conclusion. Chiefly, it would seem, for the thrill of the tickling paradox (p. 22, par. 2), at times to vent a prejudice through an untruthful criticism (p. 20, par. 2). Often we find the cart before the horse; results are offered as causes. Thus the author's notes upon the "disgusting habit" are riddled with inaccuracies as well as being jewelled with truths, but a more fundamental understanding is rarely offered. This much may be said, however, Dr. Collins is rarely stodgy, and much good science is tainted with this deadly sin. On this count we vote with Dr. Collins, but there are reservations.

When he states that the "time to sublimate sex repressions is before they are repressed" he is talking nonsense. Much sex repression is phylogenetic and racial and already repressed in the pattern before birth; it is beyond the reach of the individual or the pedagogue. But this is a technical problem and Dr. Collins

[1] *The Doctor looks at love and life*, by Joseph Collins.

is not strong on technical distinctions, particularly for repression and suppression. We have but one definite criticism of chapter I and that is that practically every bit of wisdom it contains has been derived from psychoanalytic investigations.

Noting next that the author does not comprehend the homosexual component of jealousy, let us pass to his curious treatment of homosexuality. This chapter is a curious one. Dr. Collins delivered it in part at a meeting of the American Neurological Association. Many who heard it wondered. Our author seems strangely ignorant of the general thesis of bisexual development (save for a few pointless phrases on p. 102) and nearly always uses the epithet homosexual when he should more scientifically distinguish between homosexual component, latent and overt homosexuality, passive and active. Failure to distinguish these main evolutionary stages in the psychosexual renders this chapter turgid with feeling, pock-marked with opprobious epithets, riddled with faulty generalizations and thus of little value as a scientific discussion.

Part II: Life: Dramatic portrayal: "Adult Infantilism", the portentous egoistic epithet, as if for centuries satirists had not called attention to the moron majority of mankind.

"Adult infantilism is our chief deficiency as a people, our most conspicuous national shortcoming". We do not pretend to be an inch behind our modern Voltaire in deriving amusement from the antics of many of our fellow-men, but the real crux of the difficulty lies deeper than the author cares to enter. His own difficulties show up most glaringly when he professes to tackle psychoanalysis. When he would speak of Freud's ignorance of the history of philosophy and science, he certainly is a dweller in the very castle of Moronia. For Freud's early teachers, Brücke and Mach were distinguished for their contributions in these fields. Collins ideas of Freud are mostly copied verbatim from Wittels —who himself had the grace to say that his presentation of Freud was purely one "as seen through a temperament", i.e. the temperament of a "journalistic flaneur".

He pictures Freud (p. 221): "The most prejudiced sane man in the world, he rails against prejudices—in season and out". The reviewer has read ten volumes of Freud's collected works: he finds no railing against prejudices—only a careful exposition of their origins and developments, and an almost sublime understanding of them and patience with them. The only prejudice we find is his prejudice for the rigid application of empiricism in scientific investigation. For this he would give and has given his life blood.

The strangest part of this chapter is the author's belying of nearly everything that has preceded it. Almost the only valid part of his entire book is founded upon the data made current by Freud —of course glimpsed here and there and not in small measure by able men before him, of whom Freud himself is well aware, and unhesitatingly says so when occasion offers.

Dr. Collins (p. 223) purports to support his description of psychoanalysis upon an American edition of a "General Introduction to Psychoanalysis". Apparently he is unaware that the translation was so wretched that another was made. Collins only quotes the inferior article, and very little of that; furthermore he nowhere indicates that the "General Introduction" was a series of lectures to a lay audience. Collins speaks of the "content of unconsciousness". Freud only speaks of the "content of the unconscious". The former is nonsense (borrowed from the bad translation), the latter is a scientific hypothesis, and as such is as valid as any "X" for the purposes of exploration. Dr. Collins' whole chapter on "adult infantilism" is but a cheap, and lazy exposition of the "infantile factors in the unconscious" which Freud illumines in a rich, rigidly scientific and humble manner.

One bubble of buncombe we would specifically prick (p. 238). "In Charcot's clinic there was a young psychologist who has become world-renowned; Pierre Janet". We have no wish to detract from Janet's most excellent work. He was not a member of the Charcot clinic, in 1885, when Freud *was* a worker with Charcot and translated some of his lectures into German. Janet at this time was not a doctor either of medicine or of philosophy (he got his M.D. in 1893), he was teaching in high schools (Chateauroux 1884-1886) (Havre 1886-1889). Only as late as 1889, did he take his Ph.D. thesis with his "Automatismes Psychologiques" from material gathered while he was an agrégé in the Lycée at Havre. He was quite unknown in Paris until later years (he came to Charcot in 1890) and Collins' quotation from Janet (p. 238) given first in 1913 (published in 1926 in English translation) does less credit to Janet's claims than to Freud's frequent charitable reference to Janet's work in his earlier writings.

If, as Dr. Collins states, he himself was studying neurology in a German University in 1893 (not quite correct, for Dr. Collins was studying at Edinger's laboratory in Frankfurt, and Frankfurt was not then a University), and *was* "deeply impressed" by the first of the Freud papers (1893) in the *Neurologische Centralblatt* (a Berlin Medical Journal, Collins calls it), he certainly shows an amazing ignorance of the whole situation, which he says he was study-

ing and testing ever since. Collins repudiates "repression" in speaking of Freud's use of the term, but uses the conception hook, line and sinker throughout his entire book. On many pages he accuses Freud of only speaking of the "sex complexes", "instincts"; on another (p. 228) "the czar of the complexes is the ego complex". He tells us (p. 229) that "Freud contends that education is indirectly responsible for neuroses". This is one of those specious statements fond to journalistic temperaments—"Bad" education, Freud states, just as Collins himself tries to show in his earlier chapters.

But why go further into Dr. Collins "affective inhibitions" *re* psychoanalysis? He has revealed in this very book the chief source of them. If "adult infantilism is the major curse of the American people", may we, without malice, cite this chapter as an exemplification of it—for Dr. Collins certainly does not claim to be other than "American".

SMITH ELY JELLIFFE.

On Stimulus in Economic Life by SIR JOSIAH STAMP (Cambridge University Press, 3/-).

The Rede Lecture of this year, as Sir Josiah Stamp himself remarks deviates somewhat from the main type to which the interpretation of the Rede Foundation has given rise. Precedents are, however, to be found in Sir Michael Foster's address on "Weariness", and Sir Francis Galton's "Measurement of the Human Faculty", to which the present publication is a worthy successor.

Sir Josiah's main concern is naturally with economic considerations proper, and here the orthologist will note that the distinction between "increased scope" and "stimulus" has been made necessary by confusions which are probably for the most part verbal in origin. Readers of Dr. Sargant Florence's *Over-Population* and *Economics and Human Behaviour* in the Psyche Miniatures will be glad to find that this author's earlier work on Fatigue is treated with due recognition of its importance.

In the psychological field Sir Josiah has read widely, and he devotes considerable attention to improved conditions of work in a section of the Physiology and Psychology of Labour Tasks. He mentions, in particular, optimum points of temperature, ventilation and humidity, especially in certain industrial processes; arrangement of spells of continuous work, giving maximum production, minimum fatigue, minimum accident rates, minimum defective work; comparisons of days and night work with similar objects; the accident curve of consecutive hours of work; the effects of overtime differently arranged; motion studies involving a rearrangement of manual movements. Experimental tests

may show, he adds, the optimum load—thus Taylor found that when pig-iron loads were 92 lbs. a first-class workman could only be under load 43 per cent of his time, and reducing the load improved the percentage, so that the output was increased as much as 276 per cent.

These cases are what Sir Josiah called " increased scope " rather than any change in incentive, or stimulus, so that if they fall within his subject at all they do so only as regards the *stimulus* to discover such short cuts, or improved methods, or physiological reactions. This stimulus may spring from scientific curiosity, in the psychologist from economic interest, in the effects upon production; from humanitarian motives, in a desire to minimise fatigue, ill-health, or monotony.

Sir Josiah recalls that when Sargant Florence is discussing the scope of fatigue and unrest and its graduations from positive ill will at one end to ill-health in occupational disease, he likens them to a spectrum in their shading off, a " notion of a kaleidoscope of moods and conditions . . . facilitating a solution of what may be called the variations of the stimulus imbroglio." Variability of stimulus has given rise to trouble to the student unnecessarily because of its use for two distinct types: (*a*) variations in *external* incentive, such as payment of a higher or lower piece rate or the approach of holidays, and (*b*) variation in the shade of capacity or willingness, *i.e.* in the inward stimulus or intensity with which the human being is working, variations which may or may not be the result of variations in some external stimulus.

He summarizes his psychological excursus as follows:

" My survey of what we know about the reactions to stimulus in different fields of scientific inquiry in a quantitative sense, indicates that the extent of precise measurement has been very scanty, and no generalisations are yet possible. But so far as classification is concerned, illustrations can be found in general terms, for every type that I first set out as hypothetically possible. We can carry over into the economic field, no single type or line of thought, and it behoves us, therefore, without vague preconceived notions drawn from doses and drugs, to scrutinise every case of economic stimulus to ascertain its true character, warned by the variety of the findings in the constituent physical, physiological and psychological elements, that we must expect wide differences and vital distinctions. It may certainly be said that we have definite teaching in the psychological experimental field to suggest valuable and positive lines of advance in those economic reactions which follow from stimulus to acquire mental skill, knowledge and improved ideas."

The conclusion of the whole matter is that discriminating emphasis should be laid upon what really lifts the economic life. The affective nexus, as opposed to the monetary nexus, is allowed to lie comparatively neglected, though the unexpected reserves of energy that are only drawn upon by emergency are fully recognized.

"The economic response may conceivably be attained by new or substituted incentive, in which the laws of increment may differ. The stimulus along the wage incentive may conceivably have one kind of reaction, whereas that to the fame or hobby incentive may have quite another. It may thus be possible to get a permanent gain to stimulus by changing the form of the incentive. Physiologically, the reactions to substituted stimulus have not indeed shown this, but there is frequently no exact parallel between the physiological and the mental."

For this last remark appeal is made to Watson, and one is therefore left wondering just what attitude Sir Josiah takes to the Double Language hypothesis, which Watson himself has not yet found time to consider.

A. M.

Psychologies of 1925 (Oxford University Press, 28/-).

The second edition, eight months after publication, of this informative work giving the considered opinions of nine representative psychologists on the fundamentals of their science, in the form of lectures at Clark University, is a very gratifying event. Four of the contributors are also contributors to *Psyche*, two others Woodworth and Morton Prince are well known in England, while the work of Professors Hunter, Dunlap and Bentley is equally worthy of further study.

Dr. John B. Watson gives us one of his most trenchant discussions of instinct, Professor McDougall raises the pertinent query Men or Robots?, Wolfgang Köhler tells us more about the Mentality of Apes, and the subject of the frontispiece to this issue of *Psyche* elaborates his well-known theory of Mental Development in terms of *Gestalt*.

P. M.